TM 11-2415

WAR DEPARTMENT TECHNICAL MANUAL

PSYCHROMETER EQUIPMENT

ML-313/AM

WAR DEPARTMENT *5 MARCH 1945*

TECHNICAL MANUAL

PSYCHROMETER EQUIPMENT ML–313/AM AND ML–313A/AM

CHANGES
No. 1

DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *12 June 1950.*

TM 11–2415, 5 March 1945, is changed as follows:

The title of TM 11–2415 is changed to read—

PSYCHROMETER EQUIPMENTS ML–313/AM AND ML–313A/AM

PART ONE

INTRODUCTION

Note (added). Psychrometer Equipment ML–313A/AM is similar to Psychrometer Equipment ML–313/AM except as otherwise specified in these changes.

In the following paragraphs change Psychrometric Calculator ML–322/UM to read—Psychrometric Calculators ML–322/UM **and ML–322A/UM:**

Paragraph	*Line*	*Paragraph*	*Line*
7	3	18	3
9*b*	12	18*c* (3)	1
17*c*	Heading	18*c* (Note)	3

1. General

* * * * * * *

c. Corrections are applied * * * and temperature values. **The psychrometric calculator used with Psychrometer Equipment ML–313/AM has been calibrated using vapor-pressure valves measured over water at wet-bulb temperatures above freezing, and over ice at wet-bulb temperatures below freezing. The psychrometric calculator used with Psychrometer Equipment ML–313A/AM has been calibrated using vapor-pressure values measured over water at wet-bulb temperatures both above and below freezing. Since the saturation vapor pressure over water below**

*These changes supersede TB 11–2415–1, 15 March 1946.

AGO 2442B June 851746 - 50

freezing is greater than that over ice at the same temperature, relative humidity and dew point computed on the ML–322A/UM will be lower than that computed on the ML–322/UM for dew points below freezing. The two calculators will provide identical psychrometric information at dew points above freezing.

3. Table of Major Components (fig. 2)

Quan	Components	Dimensions (in.)			Diameter	Weight (lb)
		Length	Width	Height		
*	*	*	*	*	*	*
1	Psychrometric Calculator ML–322/UM **(with ML–313/AM) or ML–322A/UM (with ML–313A/AM).**	------	------	------	10	3/8
1	Running spare parts:					
*	*	*	*	*	*	*
	4 gaskets, **psychrometer support (ML–313/AM).**	------	------	------	2 5/8	------
	or					
	2 gaskets, psychrometer support (ML–313A/AM).	------	------	------	2 5/8	------
	2 gaskets, ventilator cover (ML–313A/AM).	------	------	------	**5**	------

In figure 2, change item 7 of the legend to read—Psychrometric Calculator ML–322/UM **(with ML–313/AM) or Psychrometric Calculator ML–322A/UM (with ML–313A/AM).**

5. Ventilator (fig. 3)

The aluminum ventilator is a highly polished, streamlined radiation shield which contains a cone-shaped passageway **(fig. 13)** for the air. The air enters * * * the inner plate.

In figure 5, change the call-out "Psychrometric Calculator ML–322/UM" to read—Psychrometric Calculator ML–322/UM **or ML–322A/UM.**

8. Location of Psychrometer Equipment ML–313/AM (fig. 6)

* * * * * * *

b. In general, the * * * the following considerations:

* * * * * * *

(2) Mount the ventilator * * * changes of curvature. **Avoid rounded surfaces such as turrets and blisters.**

* * * * * * *

In figure 6, change the call-out to read—Ventilator of Psychrometer Equipment ML–313/AM **or ML–313A/AM.**

10. Assembly (fig. 3)

Install the ventilator * * * an airplane mechanic. **The doubler plate should be fabricated locally.** The tools required * * * be installed (par. 8).

* * * * * * *

a. (Superseded.) Rivet the doubler plate to the wall of the airplane (fig. 1) so that when the psychrometer equipment has been installed, its weight will be distributed over at least two structural reinforcements. The doubler plate strengthens the skin of the airplane and anchors the ventilator to the structural members of the fuselage. The plate may be attached to the inside or the outside of the skin, according to the construction of the airplane.

b. Drill a 2-inch hole for the ventilator tube **through the doubler plate and the airplane skin (par. 8*a*).**

c. (Superseded.) Remove the six stay bolts and the inner faceplate from the ventilator, and insert the ventilator tube into the 2-inch hole from outside the airplane.

d. (Superseded.) Position the ventilator (par 8*a*), and mark hole positions on the airplane surface through the six outer-faceplate bolt holes. Remove the ventilator and drill six ¼-inch holes in accordance with the markings.

Note **(Added.) Holes must be drilled so that the center line of the conical air passageway of the ventilator (fig. 13) will be parallel to the air stream.**

e. **(Superseded.)** Fit the ventilator tube into the 2-inch hole (*b* above). From outside the airplane, insert the six stay bolts through holes in the outer faceplate. From inside the airplane, place the innner faceplate on the stay bolts, locating the three inner-faceplate stud bolts so that the psychrometer support will be in a vertical position when attached.

f. Rescinded.

g. Rescinded.

* * * * * * *

j. **(Added.)** A gasket is cemented to the inside of the cover plate of Psychrometer Equipment ML313A/AM. If installing Psychro-

meter Equipment ML–313/AM, cut a gasket, to the size and shape of the cover plate, from synthetic rubber sandwich (neoprene). Cement the gasket to the inside of the cover plate before installing the plate.

10.1 (added). Installation of Psychrometer Equipment ML–313/AM to Eliminate Pressure Leak

Note. This procedure is to be applied only to models of Psychrometer Equipment ML–313/AM bearing serial numbers below 700 on Order Nos. 1764–MPD–44, 1520–MPD–45, and 43356–Phila–45, installed in airplanes that have pressurized cabins.

a. The following parts, available at any United States Air Force supply depot, are required in addition to parts supplied with Psychrometer Equipment ML–313/AM:

Air Force stock No.	Requisition class	Quantity	Name of item and description
6600–773350	04B	1 sq ft	Sheet: Synthetic rubber sandwich; fuel cell; .035 to .045 inch thick.
6600–108700	04B	1-qt can	Cement: Synthetic rubber EC–678S.
8500–909000	24	1-gal can	Solvent: Methyl isobutyl ketone.
7300–245260	07	8-lb can	Compound: Sealing; zinc chromate; type No. 1.

b. When the ventilator of Psychrometer Equipment ML–313/AM is installed on an airplane, the outer faceplate of the ventilator should be sealed to the doubler plate or to the skin of the airplane, with zinc-chromate sealing compound. Apply a coating approximately one-sixteenth inch thick to the outer faceplate at the time of installation (fig. 7.1).

Note. If the ventilator already has been installed and the airplane does not have a pressurized cabin, sealing of the ventilator outer faceplate to the fuselage is not essential and may be eliminated without affecting the accuracy of the psychrometer. If the cabin is pressurized however, the junction of the outer faceplate and the skin must be sealed; the ventilator should be removed, the sealing compound applied, and the ventilator reinstalled on the airplane.

c. To prevent leakage of air from the cabin into the inner duct of the ventilator, or vice versa—with a consequent affect on readings of the psychrometer thermometers—the joint between the inner faceplate

of the ventilator and the ventilator supporting tube must be sealed. Place rubber cement around the ventilator supporting tube where it joins the back surface of the inner faceplate (fig. 7.1). This application of cement should seal the joint between the supporting tube and the inner faceplate. If rubber cement cannot be applied to this joint, apply zinc-chromate sealing compound.

d. To insure a perfect pressure seal between the psychrometer ventilator and the psychrometer support, install a rubber gasket on the inner faceplate of the ventilator (fig. 7.1).

(1) Cut a circular disk 5 inches in diameter from a sheet of synthetic rubber.

(2) On three radii, 120° apart and $1\frac{13}{15}$ inches out from the center of the disk, cut holes to permit passage of the wingnuts and stud bolts on the inner faceplate of the ventilator.

(3) Cut a circular hole $1\frac{5}{8}$ inches in diameter in the center of the disk. *This hole must be cut carefully and accurately.*

(4) Place the disk on the inner faceplate of the ventilator to determine that it fits smoothly around the stud bolts and that the center hole lines up with the opening in the ventilator supporting tube. If the fit is not exact, remove the disk and trim it to fit.

(5) Apply rubber cement to the inner faceplate of the ventilator and to one side of the rubber disk.

(6) Place the rubber disk on the ventilator faceplate, cemented side toward the faceplate, and press it firmly in place.

e. The psychrometer support that holds the thermometers also requires modification to insure a perfect pressure seal between the air in the cabin and the air in the ventilator duct. Note the arrangement of gaskets required for the psychrometer support (fig. 7.2).

(1) Remove the sponge rubber gasket attached to the flange plate of the psychrometer support, and trim it down to $2\frac{1}{4}$ inches in diameter.

(2) Bevel one side of the gasket with a scissors so that the thickness remains unchanged at the edge of the center hole and tapers to a feather edge at the circumference.

(3) Slip the modified sponge-rubber gasket on the psychrometer support, beveled side toward the flange plate. Make certain that the gasket is well seated in the cavity formed by the flare in the flange plate where it joins the horizontal tube of the psychrometer support. If the fit is not true, remove the gasket and trim it as necessary.

(4) Apply rubber cement (thinned, if necessary, with solvent) to the sponge-rubber gasket and to the cavity surface, and press the gasket into place (fig. 7.2).

(5) Cut a circular disk 5 inches in diameter from a sheet of synthetic rubber.

(6) Cut a circular hole 1⅝ inches in diameter in the center of the disk. Cut the hole carefully to insure a snug fit on the horizontal tube of the psychrometer support.

(7) Apply rubber cement to the flange plate of the psychrometer support, coating the modified sponge-rubber gasket already cemented to the flange ((4) above). Apply rubber cement to one side of the rubber disk, and slip it over the horizontal tube of the support, cement-coated side toward the psychrometer flange. Press the disk firmly in place against the psychrometer flange (fig. 7.2).

(8) With a knife or razor blade, cut openings in the disk to correspond to keyhole slots in the flange plate.

f. The psychrometer support is designed to provide a pressure seal around the thermometer stems where they pass through the phenolic plug in the horizontal tube. When the wire thermometer guards are screwed tightly in place, the rubber bearings inserted in the guard sockets effect this pressure seal. However, a defective bearing may cause a leak between the cabin and the ventilator duct.

(1) To check for such a leak, lock the psychrometer support in operating position in the ventilator. Then, holding a finger tightly over the exhaust opening of the duct to seal it, blow into the entrance opening of the duct. Have a second man detect any leak by listening for a whistling or hissing sound around the thermometer stems. A film of water spread over the thermometers where they enter the phenolic plug at the open end of the psychrometer support tube will indicate the presence of a leak, if bubbles pass through the water film.

(2) If a leak is present, it can usually be corrected by replacing the rubber bearing in the wire guard socket. If replacement of the bearing fails to correct the leak, cut a spare bearing in half across its thickness, and insert it in the wire guard socket against the whole bearing (fig. 7.2). Then screw the guard in tightly. If neither replacement of the bearing nor addition of a half bearing corrects the leak, pour rubber cement into the open end of the horizontal tube of the psychrometer support (fig. 7.2) to seal completely any openings

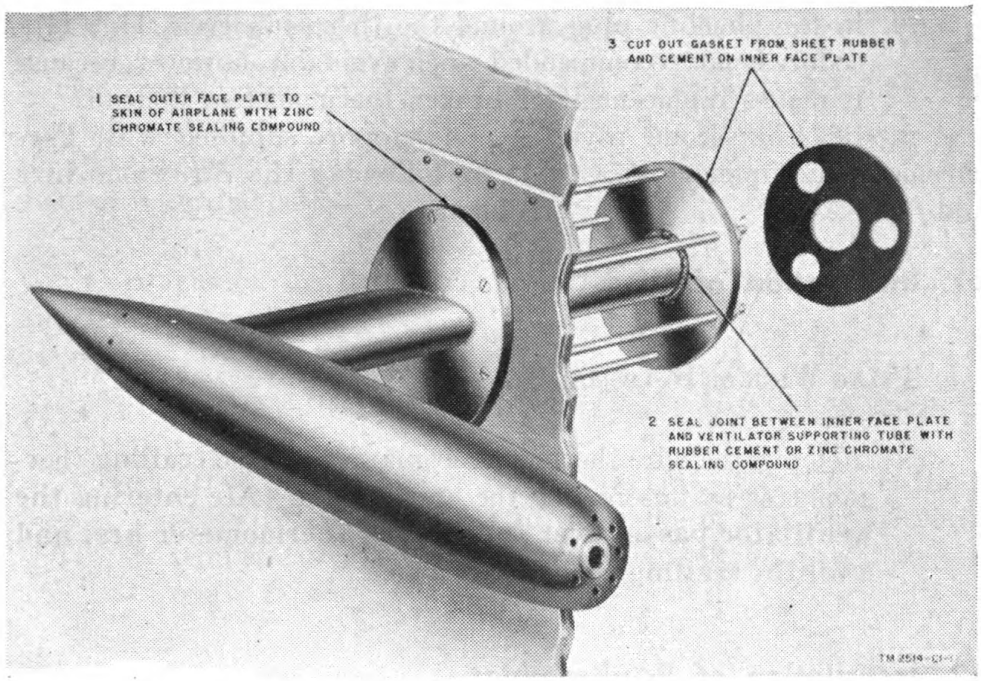

Figure 7.1 (added). *Ventilator modifications* (*par. 10.1*).

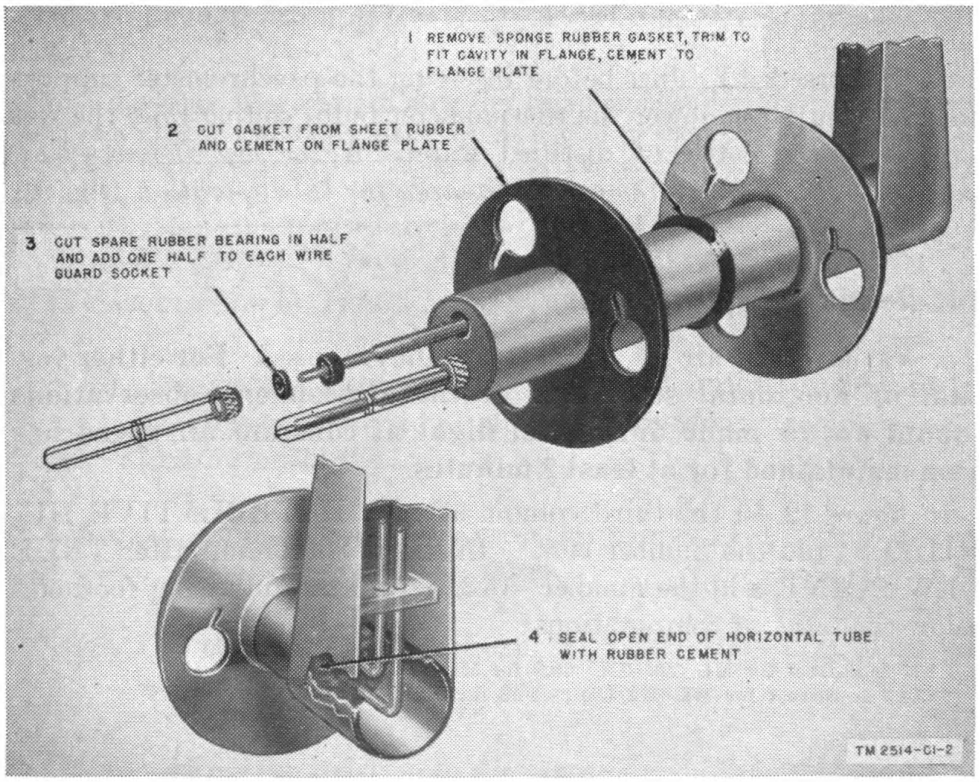

Figure 7.2 (added). *Psychrometer support modifications* (*par. 10.1*).

in the phenolic plug around the thermometers. This procedure is not recommended when avoidable, however, because it makes replacement of broken thermometers difficult.

g. Modify the second psychrometer support supplied with Psychrometer Equipment ML–313/AM, following the directions in *e* and *f* above.

11. Installation of Wick

* * * * * * *

b. Tying Wick of Bulb (fig. 8).

* * * * * * *

(2) Remove the wire thermometer guard from the **trailing** thermometer by unscrewing the knurled nut. **Air entering the ventilator passes over the leading thermometer first and over the trailing thermometer last.**

* * * * * * *

12. Installation of Psychrometer

At the beginning * * * should be used.

* * * * * * *

b. (Superseded.) Just before inserting the psychrometer support into the ventilator, lower the thermometer bulbs so that *only* the wet bulb is in the bottle of distilled water. *Never wet the dry-bulb thermometer. Do not remove the guards for this operation* (fig. 9).

* * * * * * *

14. Reading Psychrometer

a. Variations in air * * * constant air speed. **For either vertical or horizontal soundings of the atmosphere, observations should not be made until level flight at constant air speed has been maintained for at least 2 minutes.**

In figure 12, in the third column after TRUE RELATIVE HUMIDITY, add the number 69.2.[1] In the third column after TRUE DEW POINT, add the number –16.3.[2] Add the following footnotes below the table of computations:

[1] 77 is correct for ML–322/UM; 69.2 for ML–322A/UM.
[2] 14.6 is correct for ML–322/UM; –16.3 for ML–322A/UM.

18. Calculating and Recording Data

The computation of * * * Speed Calculator ML–324/UM. The tables all appear on Signal Corps Form No. 400, Correction Sheet for **Psychrometer** Equipment ML–313/AM. Record all data * * * manner indicated below.

* * * * * * *

e. Calculation of True Relative Humidity, True Dew Point, and True Vapor Pressure.

* * * * * * *

(3) Use the centigrade-millibar * * * Proceed as follows:

* * * * * * *

(*g*) Move the hairline on the Θ scale **(ML–322/UM) or the T scale (ML–322A/UM)** to the value of the true dry-bulb temperature, and read the true relative humidity in percent on the C_2 scale.

* * * * * * *

19. Illustrative Example in Computing Data

The following example * * * Psychrometer Equipment ML–313/AM.

Note (added). The assumed altimeter installation correction and the change from indicated to calibrated air speed, as shown in the example below, are not consistent because a positive altimeter correction cannot correspond to a positive installation correction for the air speed indicator. However, the example is satisfactory as an illustrative exercise.

* * * * * * *

b. Calculation of True Pressure.

* * * * * * *

(3) Assume the altimeter * * * to 3 millibars. Altimeter installation correction+altimeter **pressure**=true pressure.

3+670=673 millibars.

* * * * * * *

e. Calculation of True Relative Humidity, True Dew Point, and True Vapor Pressure.

* * * * * * *

(3) Use the centigrade-millibar * * * ML–322/UM as follows:

* * * * * * *

(*g*) Move the hairline to 2.8° (true dry-bulb temperature) on the Θ scale **(ML–322/UM) or on the T scale (ML–322A/**

UM), and read 81 percent (read to the nearest whole percent) on the C_2 scale. The true relative humidity is therefore 81 percent.

(h) Move the hairline to the index arrow, and read **–0.1°** C dewpoint temperature on the DP scale and a vapor pressure of 6.07 millibars on the VP scale.

29. Design of Psychrometer Equipment ML–313/AM

* * * * * * *

c. VENTILATOR (fig. 13).

(1) The outer shell * * * from the airplane. The outer shell of the **ventilator** serves as a radiation shield and is highly polished in order to reflect radiant heat.

* * * * * * *

31. General Repair and Replacement of Parts

* * * * * * *

c. RUBBER GASKET. Remove a damaged rubber gasket from the psychrometer support **or the cover plate,** and cement a new gasket in place. A tight pressure * * * for accurate results.

35. Technical Publications

* * * * * * *

AAF Specification No. 27987–A, Amendment No. 2, Table, Pressure-Differential (For Airspeed Indicators).

TM 11–2422, Psychrometric Calculator ML–322/UM.

38. Glossary

The following glossary * * * this technical manual.

* * * * * * *

Lucite.—A trade name for a transparent, plastic material composed of polymethyl **methacrylate;** the same material as *Plexiglas.*

* * * * * * *

[AG 300.7 (2 Jun 50)]

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TM 11-2415

PSYCHROMETER EQUIPMENT

ML-313/AM

WAR DEPARTMENT *5 MARCH 1945*

WAR DEPARTMENT,
WASHINGTON 25, D. C., 5 MARCH 1945.

TM 11–2415, Psychrometer Equipment ML–313/AM, is published for the information and guidance of all concerned.

[A. G. 300.7 (6 Jun 44).]

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(For explanation of symbols see FM 21–6.)

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TABLE OF CONTENTS

DESTRUCTION NOTICE

WHY — To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN — When ordered by your commander.

HOW — 1. Smash — Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut — Use axes, handaxes, machetes.

3. Burn — Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives — Use firearms, grenades, TNT.

5. Disposal — Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT — 1. Smash — Ventilator, psychrometer supports, thermometers, bottle, carrying case.

2. Cut — Bearings, gaskets, calculators, canvas case, carrying case, thread, wicking, ventilator, psychrometer supports.

3. Burn — Thread, wicking, calculators, canvas case, carrying case.

4. Bend — Ventilator, psychrometer support.

5. Bury or scatter — All or any of the above after destroying it.

DESTROY EVERYTHING

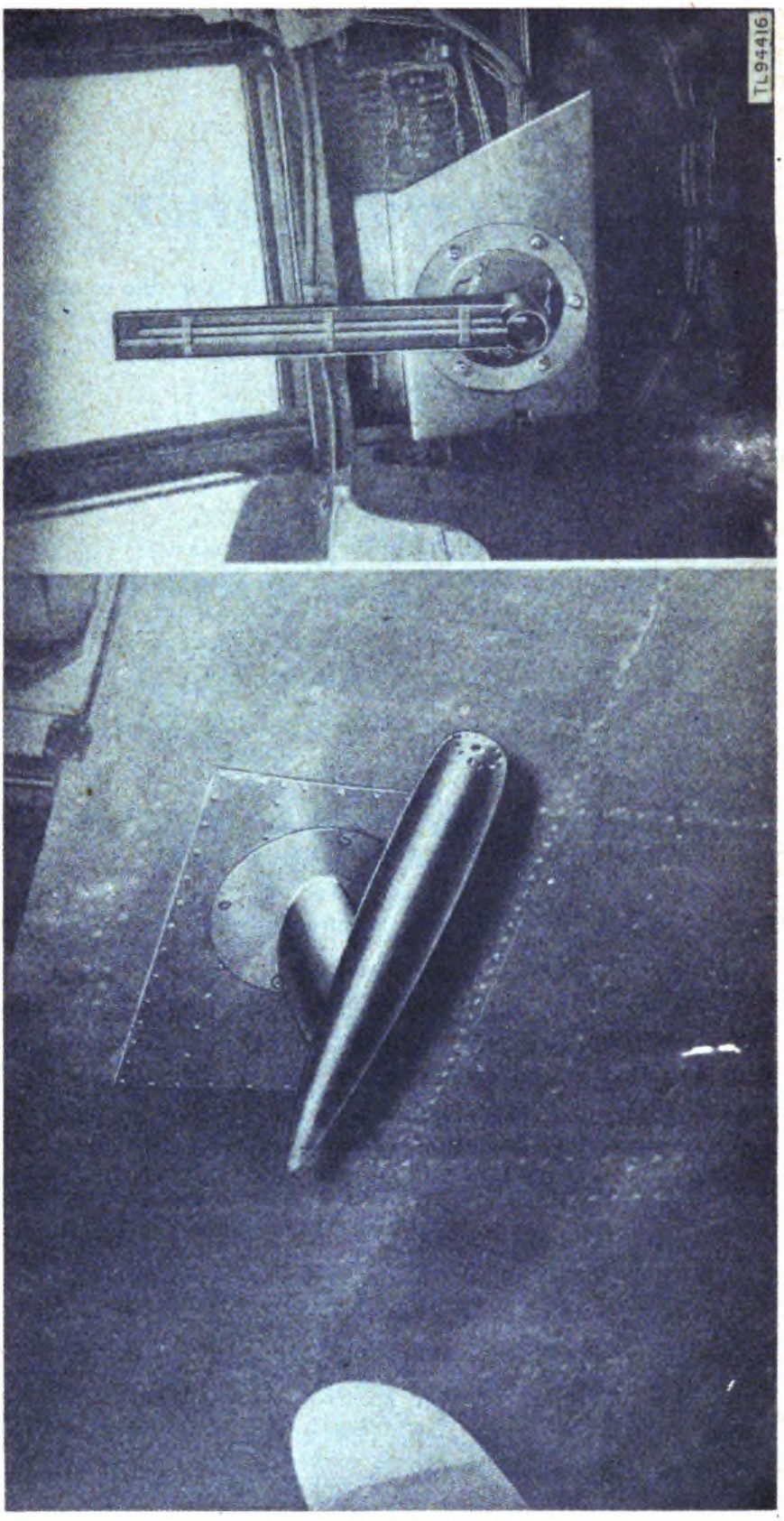


Figure 1. Psychrometer Equipment ML-313/AM, mounted.

PART ONE
INTRODUCTION

SECTION I

DESCRIPTION OF PSYCHROMETER EQUIPMENT ML-313/AM

1. GENERAL.

a. Psychrometer Equipment ML–313/AM measures, from an airplane in flight, the wet- and dry-bulb temperatures of the air. The relative humidity, dew point, vapor pressure, and temperature of the atmosphere at the level of flight may be determined from the thermometer readings.

b. The equipment consists principally of two interchangeable psychrometer supports, four right-angle thermometers, and one ventilator. One support holds two thermometers which range from –35° C to +15° C; the other support holds two thermometers which range from –0.2° C to +50° C. The range of temperatures being measured determines which psychrometer is to be used. The ventilator is designed for mounting on the fuselage of an airplane. The ventilator holds a psychrometer support so that the thermometer bulbs are exposed in a controlled air stream passing through the ventilator during flight, and so that the thermometer scales are located inside the cabin where they can be read (fig. 1). A psychrometer support can be easily removed from its operating position for the purpose of moistening a wick which is tied over one thermometer bulb.

c. Corrections are applied to the thermometer readings for the temperature and pressure rises which occur in the ventilator during flight. These effects are a function of the speed of the airplane. Calculating devices are provided as part of the psychrometer equipment to simplify the evaluation of the observed data and to determine the true humidity and temperature values.

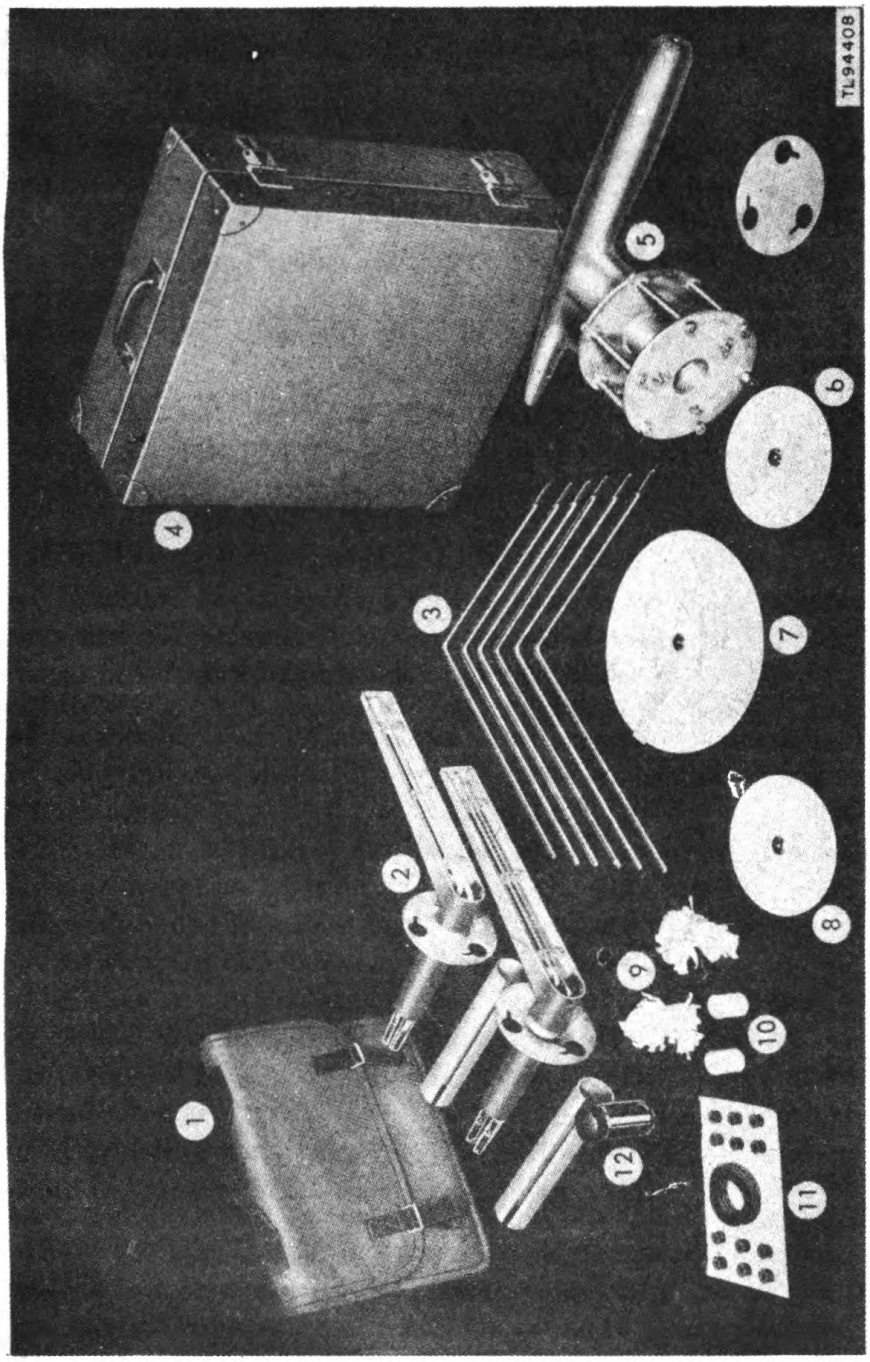
2. APPLICATION OF PSYCHROMETER EQUIPMENT ML-313/AM.

Psychrometer Equipment ML–313/AM is used to measure accurately the temperature and humidity conditions of the upper air. The data obtained from the equipment is used as a standard for the calibration of aerographs or other airborne humidity and temperature measuring devices. The equipment can also be used to make vertical or horizontal soundings of the atmosphere as part of a weather reconnaissance program.

3. TABLE OF MAJOR COMPONENTS (fig. 2).

Quan	Components	Dimensions (in.)			Diameter	Weight (lb)
		Length	Width	Height		
2	Aircraft psychrometers:	13	5	17¼	....	1 7/16
	2 supports.					
	2 thermometers, —35° C to +15° C.					
	2 thermometers, —0 2° C to +50° C.					
1	Ventilator	17¾	10¾	6¼	....	3
1	Bottle for distilled water	....	....	3¼	1½	....
1	Carrying case	18¼	20½	8	....	15
1	Case CY-295/UM	12½	14½	1	....	1 5/8
1	Air Speed Calculator ML-324/UM	....	....	....	6	3/16
1	Pressure Calculator ML-323/UM	....	....	....	6	3/16
1	Psychrometric Calculator ML-322/UM	....	....	.. .	10	3/8
1	Running spare parts:					
	2 spools of thread.					
	1 package of wicking.					
	3 thermometers, —35° C to +15° C.					
	3 thermometers, —0.2° C to +50° C.					
	12 bearings	....	....	....	9/16	....
	4 gaskets	....	....	....	2 5/8	....

NOTE: Running spare parts are for initial use only and are not to be requisitioned as a kit or group as shown in this list. Case CY-295/UM is not supplied with all equipments.



1. Case CY-295/UM.
2. Aircraft psychrometers.
3. Thermometers (7A1322-313/T1 and 7A1322-313/T2).
4. Carrying case.
5. Ventilator.
6. Pressure Calculator ML-323/UM.
7. Psychrometric Calculator ML-322/UM.
8. Air Speed Calculator ML-324/UM.
9. Wicks (7A1322-313/W1).
10. Thread (6Z8650W).
11. Bearings (7A1322-313/B1).
    Gaskets (7A1322-313/G1).
12. Bottle for distilled water.

Figure 2. Psychrometer Equipment ML–313/AM, component parts.

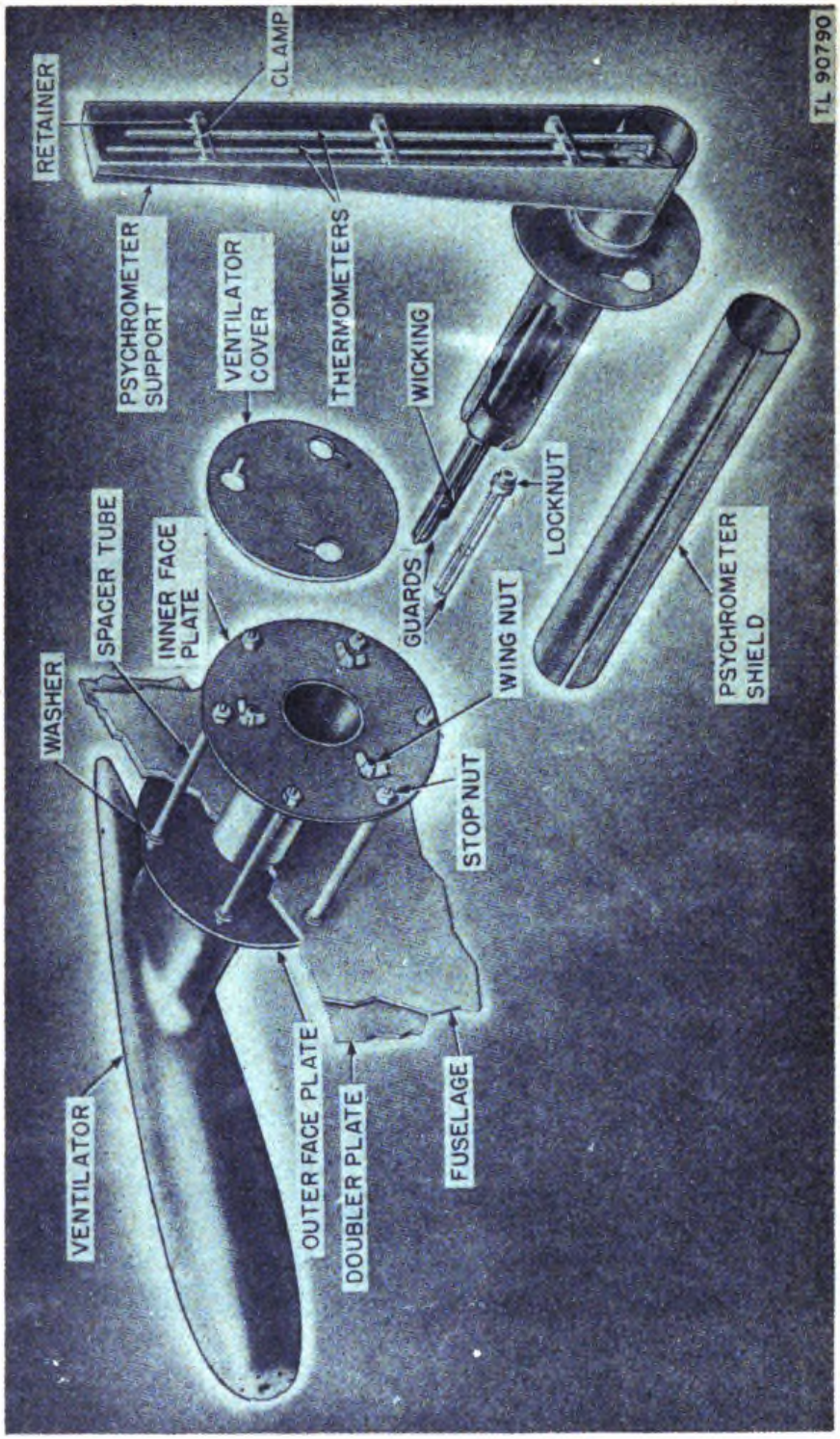


Figure 3. Psychrometer Equipment ML-313/AM, exploded view.

4. AIRCRAFT PSYCHROMETER (fig. 3).

a. Psychrometer Support. Psychrometer Equipment ML–313/AM includes two aluminum psychrometer supports which are identical in all details of construction. The vertical channel-shaped portion of each is 17¼ inches high from the bottom of the flange to the top of the support. The flange, 5 inches in diameter, has three keyhole slots for attachment to the inner faceplate of the ventilator tube. Two thermometers (subpar. **b** below) are held in the vertical channel by three lucite retainers and clamps. Each clamp hinges on a screw at one end of a retainer and hooks over a screw at the other end. With the protecting shield attached, the cylindrical horizontal portion is 13 inches long. Two phenolic tubes pass through this horizontal cylinder; a wire thermometer guard screws over the end of each tube. Each guard is fitted with a synthetic rubber bearing which provides a pressure seal around the thermometer stems. When the psychrometer is not in use, the horizontal portion and the thermometer stems are covered and protected against breakage by the cylindrical psychrometer shield.

b. Psychrometer. Each of the two psychrometers consists of one wet-bulb and one dry-bulb thermometer. All thermometers are of the right-angle, mercury-in-glass type. The wet-bulb thermometers are identical with the dry-bulb thermometers except that, when in use, their bulbs are covered with a tightly fitting cloth wick. The vertical stems of each thermometer in one psychrometer are graduated from −35° C to +15° C in steps of 0.1° C. The other psychrometer consists of two thermometers graduated from −0.2° C to +50° C in steps of 0.1° C. The horizontal portion of each terminates in a cylindrically-shaped bulb of mercury. The retainers and clamps securely hold the vertical stems upright inside the support channels. The mercury bulbs are slipped through the phenolic tubes in the psychrometer supports.

5. VENTILATOR (fig. 3).

The aluminum ventilator is a highly polished, streamlined radiation shield which contains a cone-shaped passageway for the air. The air enters the conical passageway through an opening in the nose of the ventilator and leaves through another opening in the tail. This passageway is surrounded by another air tube into which air enters through eight small holes arranged in a concentric circle around the opening to the passageway. The air leaves through eight small holes around the wall of the tail. Toward the tail, a supporting tube within a streamlined strut is secured at right angles to the main body of the ventilator. The supporting tube is fitted with an outer faceplate separated from an inner faceplate by six spacer tubes bolted to the inner plate. The inner faceplate is kept flush with the end of the tube. When the psychrometer is not in use, a ventilator cover provided with three keyhole slots is tightened over the tube opening by means of three wingnuts on the inner plate.

6. CARRYING CASE (fig. 4).

The carrying case is a wooden box about 18¼ inches long, 20½ inches

wide, and 8 inches deep. It consists of two sections fastened together by four trunk catches. The six spare thermometers are stored in a removable felt-lined compartment under a false bottom in the top section of the case. The removable compartment is closed by three lockscrews and is held in place by rubber bumpers when the false bottom is closed. When the equipment is packed for export, the thermometers are packed in a separate plywood case (par. 9 **a** (4) (**e**)). The psychrometer supports, with the correct thermometers mounted and clamped in them, rest on felt-covered stocks in the bottom section of the case. These supports are strapped in place by six cotton webbing bands which are secured by lift-o-dot fasteners. The boxlike compartment in the center of the bottom section stores the thread, wicking, bottle for distilled water, and spare gaskets and bearings. A handle is provided on the case for carrying.

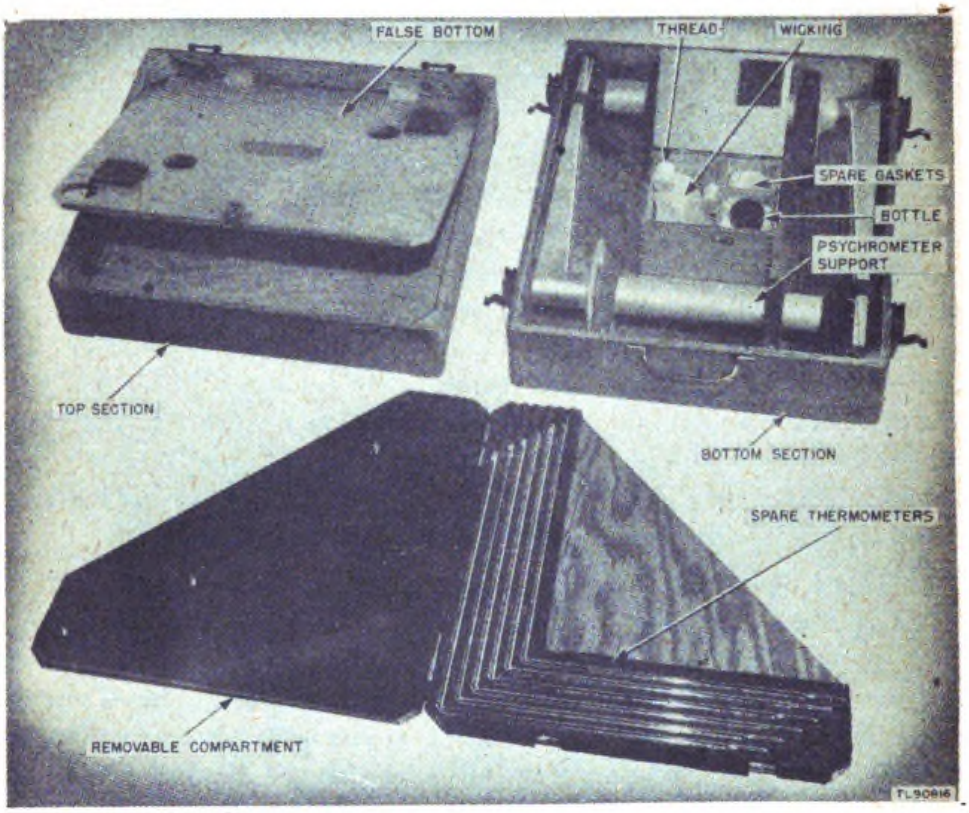


Figure 4. Carrying case for Psychrometer Equipment ML–313/AM, opened.

7. CASE CY-295/UM (fig. 5).

Case CY–295/UM is supplied as a convenient means of carrying and storing Air Speed Calculator ML–324/UM, Pressure Calculator ML–323/UM, Psychometric Calculator ML–322/UM, and Forms SC No. 421 and SC No. 400. The case is made of canvas and is kept closed by two cotton webbing straps which slip through two single-bar buckles. The top of the case is provided with a cotton webbing handle. The inside of the case is partitioned into seven pockets in which the various contents of the case are stored. On the top inside

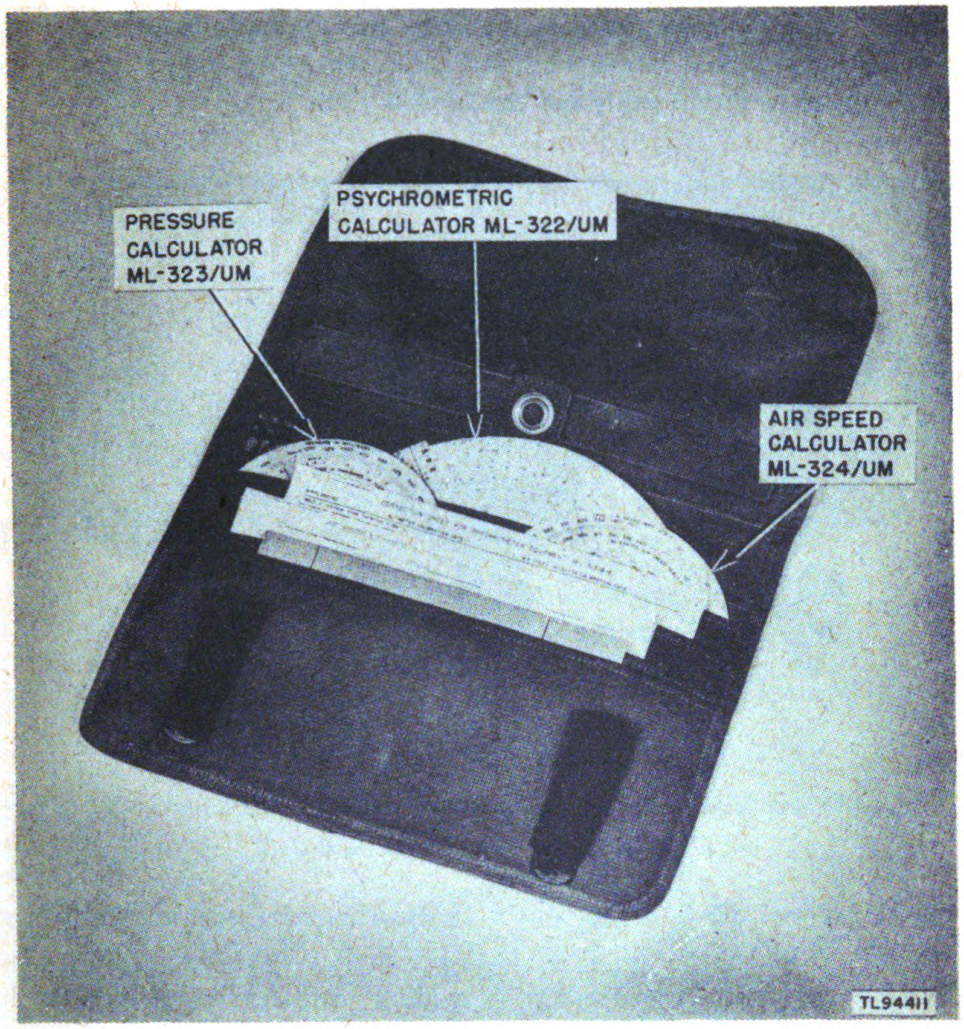


Figure 5. Case CY–295/UM, opened.

binding, a 2-inch piece of cotton webbing containing a metal grommet and washer is provided to hang the case on a hook on the inside wall of the airplane. All outside and pocket edges of the case are bound with cotton webbing.

SECTION II
INSTALLATION AND ASSEMBLY

8. LOCATION OF PSYCHROMETER EQUIPMENT ML-313/AM (fig. 6).

a. In order to obtain the best results, the location of Psychrometer Equipment ML–313/AM must be carefully selected. Locate the ventilator on the fuselage of the airplane where the axis of the ventilator is parallel with the air stream and where the air entering the ventilator during flight is not affected by blasts from the propellers, heat or exhaust from the motors, or cabin heater exhausts. Mount the ventilator as far forward as possible so that a minimum of

dust will enter the ventilator during take-off and landing. Select a location where the psychrometer supports inside the airplane are adequately lighted and the thermometers can be easily and comfortably read.

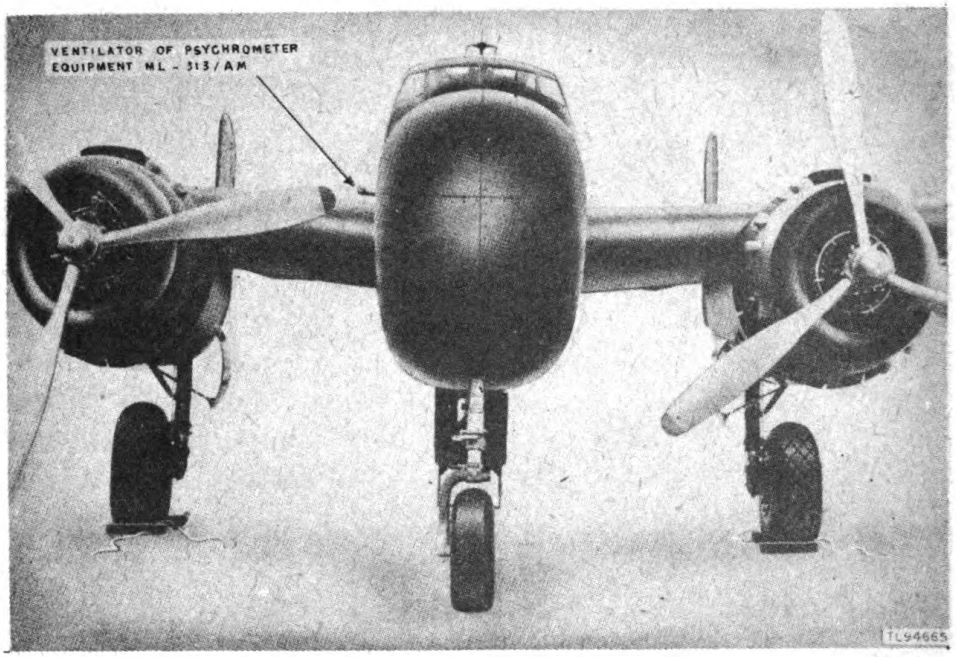


Figure 6. Ventilator mounted on B–25G.

b. In general, the final location of the psychrometer equipment is determined by the following considerations:

(1) Locate the equipment far enough forward so that it will be out of the propeller slip stream.

(2) Mount the ventilator on a section of the fuselage which has no abrupt changes of curvature.

(3) Mount the ventilator so that the psychrometer can be conveniently read inside the airplane.

9. UNPACKING, UNCRATING, AND CHECKING PSYCHROMETER EQUIPMENT ML-313/AM (fig. 7).

a. The equipment is transported in a closed wooden box (19¾ inches long, 21 inches wide, and 20¼ inches high) which occupies a volume of 6½ cubic feet and has a gross weight of approximately 72 pounds. The box has a waterproof lining. To unpack the equipment, proceed as follows:

(1) Pry open the top of the box and tear open the waterproof lining.

(2) Remove the false section and lift out the ventilator carton. Open the carton and carefully remove the fully assembled ventilator. Examine the ventilator for dents and damages before disassembling it for installation (par. 10).

(3) Remove the compartment in which the six spare thermometers are stored.

Remove the waterproof covering and cut the steel strapping.

(4) Remove the carton containing the carrying case and proceed as follows:

(a) Remove the waterproof covering and lift the carrying case from the carton.

(b) Open the four trunk catches and lift off the top section. Place the top section on a flat surface.

(c) Lift up the false bottom and remove the felt-lined compartment underneath it.

(d) Unscrew the three lockscrews and open the removable compartment.

(e) Remove the spare thermometers from the plywood compartment in which they were shipped. Each thermometer is encased in and protected by a cellulose sleeve. Lift the thermometers very carefully and slip off the protecting sleeves.

(f) Place the spare thermometers in the removable compartment of the carrying case. Tighten the three lockscrews and replace the compartment under the false bottom. Be sure the false bottom is locked so that the compartment will be held securely by the rubber bumpers.

(5) The cardboard carton and the wooden box may be discarded. The psy-

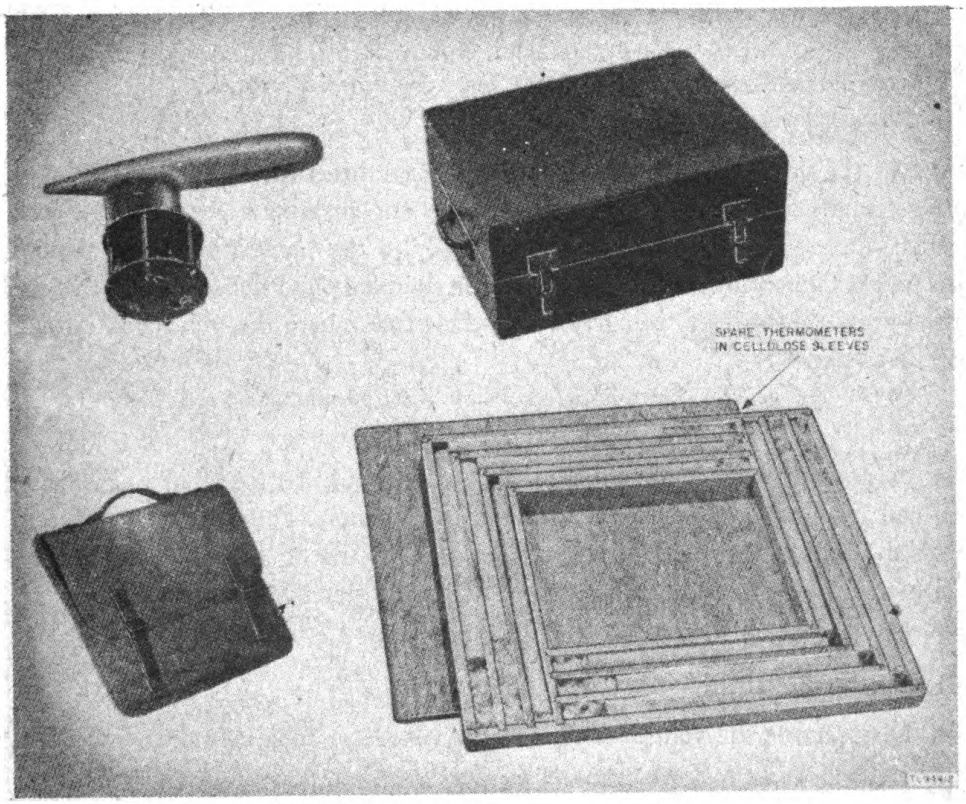


Figure 7. Psychrometer Equipment ML–313/AM, uncrated.

chrometer supports and spare parts are packed in the carrying case. Keep the parts in the carrying case whenever they are not in use. The three calculators and the technical manuals are in the canvas case.

b. Check the contents of the wooden shipping box with the following list:

1 ventilator
1 carrying case which contains:
  1 psychrometer support with 2 thermometers, –35° C to +15° C
  1 psychrometer support with 2 thermometers, –0.2° C to +50° C
2 spools of white thread
1 bottle for distilled water
1 package of wicking
4 gaskets
12 bearings
1 Case CY–295/UM which contains:
  1 Psychrometric Calculator ML–322/UM
  1 Pressure Calculator ML–323/UM
  1 Air Speed Calculator ML–324/UM
  2 each technical manual (TM 11–2415)
1 plywood case which contains:
  3 spare thermometers, –35° C to +15° C
  3 spare thermometers, –0.2° C to + 50° C

NOTE: When Case CY-295/UM is not supplied with the equipment, the three calculators and the two technical manuals are shipped in the carrying case. Forms SC No. 421 and SC No. 400 are furnished separately.

10. ASSEMBLY (fig. 3).

Install the ventilator at an air field having facilities for making minor alterations to an airplane. The tools required for installation (drill, hacksaw, wrench, file, screwdriver) are those generally in the possession of an airplane mechanic. The tools required to install the doubler plate depend upon the construction of the wall of the airplane at the place where the ventilator is to be installed (par. 8).

NOTE: The general directions given below must be modified for airplanes of different types and different models.

a. A doubler plate, to be fabricated locally, should be installed to distribute the load over at least two structural reinforcements. The doubler plate reinforces the skin of the airplane and anchors the ventilator to the structural members of the fuselage. The construction of the airplane determines whether the plate is installed on the inside or outside of the skin.

b. Drill a 2-inch hole for the ventilator tube.

c. Disassemble the ventilator and fit the ventilator tube into the 2-inch hole.

d. Insert a psychrometer support into the ventilator to check the exact location of the six holes for the six stay bolts before the holes are drilled. Locate

the holes for the stay bolts so that, when the stay bolts are tightened, the ventilator will point into the air stream when the airplane is in flight (fig. 1). The center line of the conical air passageway must coincide with the direction of level flight of the airplane.

e. Locate the stud bolts on the inner faceplate so that the psychrometer support is in a vertical position when the bolts are tightened.

f. Drill six ¼-inch holes.

g. Place the ventilator in position. Insert the six bolts and add the inner faceplate.

h. The end of the ventilator tube must be flush with the inner faceplate (fig. 3). Never change the length of the ventilator tube by cutting or grinding. Use spacing tubes or washers (or both) over the stay bolts to make the faceplate flush with the ventilator tube. The spacing tubes may be shortened. Adjust the length of the spacing tubes or the number of washers, and tighten the stop nuts on the inner faceplate. Examine to see if the ventilator tube is flush with the inner faceplate. Loosen the stop nuts, readjust the length of the spacing tubes, and retighten the stop nuts as often as necessary until an *exact* fit results.

i. When the faceplate is flush with the ventilator tube, tighten the stop nuts.

NOTE: If the curvature of the skin of the airplane causes a loose fit, insert a fitted shim between the ventilator and the skin.

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PART TWO
OPERATING INSTRUCTIONS

NOTE: For information on the destruction of this equipment to prevent its use by the enemy, see the destruction notice at the front of the manual.

SECTION III
PRELIMINARY PROCEDURES

11. INSTALLATION OF WICK.

a. Preparation of Wick. Thermometer wicking, as it is delivered from the manufacturer, contains a sizing which must be washed away before the wicking can be used on the wet-bulb of a psychrometer. Proceed as follows:

(1) Boil the wick in a weak caustic solution or in a strong soap solution.

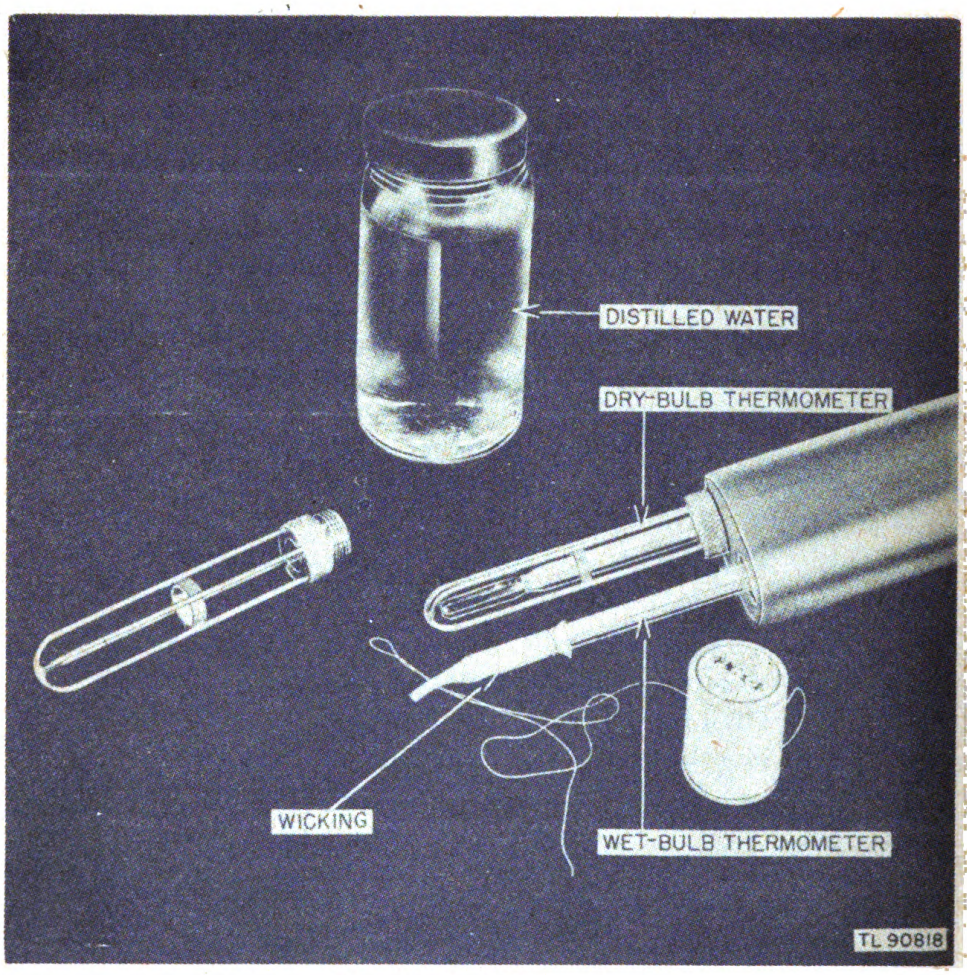

Figure 8. Installing wick.

(2) Wash the wick thoroughly in boiling distilled water until no soap or caustic soda remains in the wicking. If distilled water is not available, use only water suitable for drinking. Avoid chemically treated water since chemicals may change the thermometer readings obtained.

b. Tying Wick on Bulb (fig. 8). (1) Remove the psychrometer shield from the support.

(2) Remove the wire thermometer guard from the lower thermometer by unscrewing the knurled nut.

(3) Slip a piece of wicking approximately 3 inches long over the thermometer bulb until the bulb is covered from above the constriction to the end.

> **NOTE:** Oil or perspiration transferred from the hands to the wick will cause a serious error in the operation of the thermometer. Hold a small piece of paper between the fingers and the wick, or wash the hands thoroughly *immediately* before installing the wick.

(4) Fasten the wick with white cotton thread at the constriction at the top of the bulb.

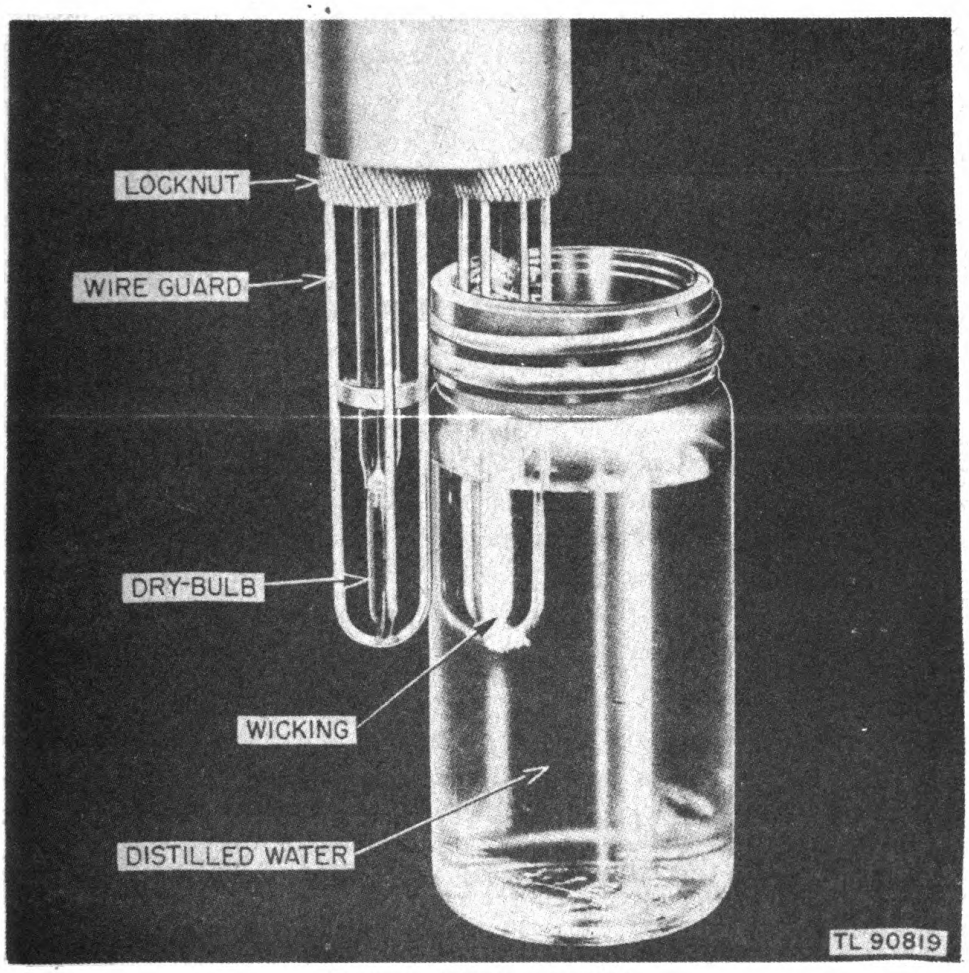

Figure 9. Wetting the wick.

(5) Stretch the wick until it fits the bulb snugly. Tie it securely just beyond, but close to, the end of the bulb.

(6) Clip off the wick 1/8 inch beyond the tie.

(7) Replace the thermometer guard and the protecting shield.

12. INSTALLATION OF PSYCHROMETER.

At the beginning of a flight be sure that both psychrometers are in the carrying case. The temperature at the time the readings are to be taken determines which psychrometer should be used.

a. Remove the psychrometer shield.

b. Lower the bulbs so that only the wet bulb is in the bottle of distilled water. Do not remove the guards for this operation (fig. 9). *Never wet the dry-bulb thermometer.*

> **NOTE:** Wet the wick just before inserting the psychrometer support into the ventilator.

c. Remove the cover plate from the ventilator tube.

d. Insert the psychrometer into the ventilator tube so that the psychrometer support is in an upright position, and the keyhole slots on the psychrometer flange fit over the wingnuts.

e. Turn the psychrometer flange so that the slots slide under the wingnuts; then lock the flange into position by tightening the wingnuts. The wingnuts must be tightened securely to prevent a leak in the ventilator pressure; otherwise serious errors result in the humidity observations.

13. PRECAUTIONS ON HANDLING PSYCHROMETER EQUIPMENT ML-313/AM.

a. Always keep the psychrometer equipment in the carrying case when not in use. Take special care not to drop the case or hit it against solid objects. Although the thermometers in the psychrometer supports and in the spare thermometer compartment in the top section of the carrying case are protected against breakage due to normal transportation vibrations, they can be broken by rough handling or sudden jars. Do not entrust the movement of the carrying case to personnel who have not been fully informed of the delicate nature of the instruments it contains.

b. Whenever possible, open the carrying case by unlatching the four trunk catches and separating the top section of the case from the bottom section, as shown in figure 4. Always provide support for the top section if the case is opened by unlatching only two trunk catches on one side of the box and hinging the top section on the other two catches. If the case is opened to the extreme position without support, the weight of the top section will tend to break the box at the corners.

c. To remove a spare thermometer from the carrying case, remove the top

section of the case and place the section flat on a supporting surface. Figure 4 shows the proper position of the section when a thermometer is to be removed.

d. Handle the psychrometer with the care necessary for any delicate equipment. When replacing a thermometer, always hold the thermometer near the right-angle bend with one hand. Never attempt to replace a thermometer while the airplane is in flight.

e. Do not strike the ventilator or psychrometer support with any tool or heavy object. Aluminum is very easily damaged.

f. Insert the psychrometer support into the ventilator carefully without the use of force. If the keyhole slots in the support do not fit easily over the studs on the inner face plate of the ventilator, carefully file the keyhole slots to make the proper fit.

g. Use only clean water (distilled or rain water preferred) on the wet-bulb thermometer.

h. Never overboil or use too strong a caustic solution when washing the wick. Rinse the wick in distilled or clean water only.

i. Do not allow oil or perspiration from the hands to be transferred to the wicking (par. 11**b**(3) NOTE).

j. Before wetting a wick, be sure that both thermometers of the psychrometer indicate the same temperature. When the psychrometer is used after it has been exposed to temperatures above its upper range, some mercury may become lodged in the expansion bulb. If so, hold the psychrometer support firmly in one hand, and slap the sides of the support with the open palm until the drop of mercury is dislodged and both thermometers indicate the same temperature.

k. If the two thermometers of the psychrometer do not read the same before wetting the wick, and it has been determined that no mercury is lodged in the expansion bulb, examine the mercury columns to see if there is a break or separation in the mercury. If so, gently heat the thermometer bulb in warm water or hold it near the cabin heater until the mercury below the breaks flows into the expansion bulb. Then cool the thermometer, holding the psychrometer support so that the expansion bulb is uppermost. Tap the psychrometer support to prevent particles of mercury from remaining trapped in the expansion bulb.

SECTION IV
OPERATION OF EQUIPMENT AND USE OF ACCESSORIES

14. READING PSYCHROMETER.

a. Variations in air temperature are reflected in the readings of the psy-

chrometer by variations in the dry-bulb temperature. Variations in the humidity of the air appear as variations in the wet-bulb depression. The wet-bulb depression is the temperature difference between the dry-bulb and wet-bulb thermometer readings. Record the temperatures indicated by the thermometers only when there is no apparent change in the wet-bulb depression. Stable conditions are generally reached after 2 minutes of level flight at constant air speed.

b. When the wet-bulb thermometer has been dipped in water and the psychrometer has been inserted into the ventilator in preparation for a humidity observation, read the dry-bulb and wet-bulb thermometers alternately, but do not record the readings. When continued ventilation no longer lowers the indicated temperature of the wet-bulb thermometer, the wet-bulb depression is at a maximum. Record the readings when this maximum is reached.

(1) The wet-bulb depressions decrease when the wick is drying. If the wick dries, remove the psychrometer from the ventilator and wet the wick again in distilled water.

(2) Replace the psychrometer in the ventilator and continue observations.

c. Take the following precautions when the wet-bulb temperature is below 0° C:

(1) Be sure that any ice on the wick is completely melted before inserting the psychrometer into the ventilator tube.

(2) After the psychrometer is replaced in the ventilator, the temperature of the wet-bulb thermometer may first drop, rise again to 0° C, and finally drop to its equilibrium value. The equilibrium value is the lowest temperature which is recorded for the existing humidity and temperature of the surrounding air. At this time, take thermometer readings.

(3) The wet-bulb depressions decrease slowly as the ice coating leaves the bulb. This process is so slow that the wet-bulb depression decrease can be mistaken for a change in humidity. If there is the slightest doubt that the bulb is fully coated with ice, remove the psychrometer from the ventilator and melt off the ice. (Visual examination of the wick for a full coating of ice is not reliable.) Rewet the wet-bulb wick and continue to take readings.

> **NOTE:** At the beginning of the flight immediately before the take-off, record the altimeter setting. Be sure the altimeter setting is not changed during flight when psychrometric observations are made unless the change is noted. At the time the wet-bulb and dry-bulb temperatures are recorded, obtain from the pilot the indicated altitude of the airplane. Note the time at which the readings are taken.

d. Remove the psychrometer from the ventilator, and replace the ventilator cover.

15. READING THERMOMETER.

a. To read a thermometer correctly, the observer must stand directly in front of the thermometer and must adjust his position so that his line of sight is per-

pendicular to the stem of the thermometer at the top of the column of mercury. If the line of sight is not so adjusted, an error caused by parallax may result.

b. Read the thermometers as quickly as possible, without loss of accuracy, to minimize the effects of the proximity of the observer and of radiation from surrounding objects.

c. Estimate the thermometer reading to the nearest hundredth of a degree (par. 18**a** NOTE).

16. DESCRIPTION, PREPARATION, AND USE OF TABLES.

a. General. (1) INSTRUMENTAL ERRORS. The accuracy of all quantitative measurements is limited by the inherent accuracy of the instruments with which the measurements are made. No instrument, no matter how carefully it is built, gives absolute accuracy. With carefully designed and skillfully constructed precision instruments, corrections based upon calibration tests can be applied to indicated measurements. In this manner corrected values are obtained which compensate for instrumental errors and which, therefore, have a high degree of accuracy.

(2) INSTALLATION ERRORS. The high velocity of the air stream and the disturbing effect of the airplane on the surrounding air introduce installation errors in the measurement of temperature and pressure from high-speed aircraft. The installation errors of the airplane's pressure altimeter and air speed indicator, for example, represent the effect of air speed on the pressure field surrounding the head of the airplane's pitot-static tube.

(3) CORRECTIONS APPLIED TO THE ALTIMETER. In order to obtain accurate pressure measurements with the airplane's pressure altimeter, corrections must be applied to compensate for the scale (instrumental) error and the installation error. In this technical manual, table I contains the correction for scale error, which is a function of the temperature of the altimeter mechanism and the indicated altitude. The correction for installation error, which is a function of indicated air speed, is found in table II of this manual.

> **NOTE:** The errors affecting the altimeter are discussed in detail in AAF TO No. 05-30-1, Handbook of Service and Operation Instructions, Altimeters C, D, and H Types, Section VII.

(4) CORRECTIONS APPLIED TO AIR SPEED INDICATOR. The air speed indicator, like the altimeter, must be corrected for instrumental (scale) and installation errors. With the air speed indicator, however, these errors can be combined into a single error which is a function of the indicated air speed. The indicated air speed corrected for scale and installation error is called calibrated air speed or calibrated indicated air speed. Table III (subpar. **d** below) provides the means for determining the calibrated air speed for any indicated air speed.

(5) CORRECTION APPLIED TO INDICATED TEMPERATURE. When air which is moving at high speed is obstructed and the velocity is reduced,

heating due to adiabatic compression and friction occurs at the obstructing object. When the obstruction is a temperature-measuring device, a correction must be applied to the indicated temperature to obtain the true air temperature. If an airstream is completely stopped, as a consequence of an adiabatic compression, the resulting rise in temperature of the air is $(v/100)^2$ degrees centigrade, where v is the true air speed in miles per hour. In practice, the combined effect of adiabatic and frictional heating caused by air speed can be expressed as a function of adiabatic heating alone. Generally, the value is less than $(v/100)^2$ and the formula may be expressed as

$$\triangle t = \alpha(v/100)^2$$

where $\triangle t$ is the temperature rise in degrees centigrade and where α is a constant equal to or less than 1.0 and is determined experimentally for each design of instrument. Table IV (subpar. **e** below) contains the dynamic temperature corrections in degrees centigrade to be subtracted from the indicated dry-bulb temperature to obtain the true dry-bulb temperature for Psychrometer Equipment ML–313/AM.

(6) DETERMINATION OF EFFECTIVE PRESSURE. The pressure at the surface of a body moving through a high velocity air stream is, in general, different from the ambient pressure (static pressure surrounding the body). Whether the body is an airplane or a temperature measuring device, the leading edges of the body can be under the influence of an excess of pressure amounting to full dynamic pressure. According to Bernoulli, full dynamic pressure may be expressed as $\frac{1}{2}\rho v^2$, where ρ is the air density in grams per cubic centimeter and v is the air velocity in centimeters per second. Elsewhere on the body, the excess pressure is less than full dynamic pressure and may even be a deficit. For any given thermometer arrangement, the dynamic pressure increment between ambient pressure and the pressure which exists at the thermometer bulbs may be expressed by the formula

$$\triangle p = \alpha(\tfrac{1}{2}\rho v^2)$$

where $\triangle p$ is the pressure increment, α is a constant determined by experiment, ρ is the air density, and v is the air velocity. In preparing data for Psychrometer Equipment ML–313/AM, ambient pressure is called true pressure, and the pressure which exists at the thermometers is called effective pressure. Table V is a table of pressure increments which apply to Psychrometer Equipment ML–313/AM.

b. Table I (fig. 10). (1) GENERAL. Table I consists of three vertical columns. The indicated altitudes from 0 to 50,000 feet are listed in the first column. The over-all title of the next two columns is Instrument Temperature. One column is labeled High °C and the other Low °C. The high and

low temperatures are the temperatures at which the altimeter has been calibrated or checked for scale error in the instrument shop. The corrections corresponding to the high and low instrument (calibration) temperatures are listed in these last two columns.

(2) DETERMINING ALTIMETER SCALE CORRECTION. Obtain the data to complete table I from the Altimeter Scale Correction Card (AAF Form No. 21M) which is prepared as a result of the instrument calibration and is posted by the altimeter on the instrument panel. Such calibrations should be performed every 6 months in order to insure accurate pressure measurements. This calibration must be performed with a mercurial manometer as a standard. If the instrument section of the Air Forces depot depends upon an aneroid for a standard in calibration work, the accuracy of the calibration is not likely to be satisfactory. *Calibrate the altimeter only against a mercury manometer.* Revise table I with each recalibration of the altimeter.

(3) WHEN AND WHEN NOT TO USE TABLE I.

(a) Determine the altimeter scale correction from table I whenever the altimeter and Psychrometer Equipment ML–313/AM are to be used in the calibration of aerographs and in other precision work.

(b) In routine humidity measurements where extreme accuracy is not required, table I may be ignored if the scale correction does not exceed 200 feet. With a temperature of –40° C and a relative humidity of 1 percent, an altimeter scale error of 200 feet at any altitude will cause an error in determined relative humidity of not more than 1 percent. This error decreases with increasing temperature and increasing humidity. At 30,000 feet indicated altitude, with a true air speed of 350 miles per hour, an altimeter scale error of 200 feet causes an error in dry-bulb temperature correction of approximately 0.1° C. This error will decrease with decreasing altitude and decreasing air speed. If, by examination of table I, it is determined that the scale errors will not affect the desired accuracy of the humidity and temperature determinations, then the indicated altitude of the altimeter may be used without scale correction in determining the pressure at the level of flight.

(4) HOW TO USE TABLE I. To find the altimeter scale correction, the airplane cabin temperature must be known in addition to the data in table I. Assume that the temperature of the altimeter mechanism is the same as the cabin temperature. Because the cabin temperature in any particular flight will probably not conform to either the high or low temperatures at which the altimeter has been calibrated and because the indicated altitude at the level of flight will not necessarily conform exactly to any of the values of indicated altitude which are listed on the card, double interpolation is generally necessary in the use of table I. For example, assume the Altimeter Scale Correction Card to read, in part, as follows:

Signal Corps Form No. 400

CORRECTION SHEET FOR PSYCHROMETER EQUIPMENT ML-313/AM

AIRPLANE NO. _____ ALTIMETER CALIBRATION DATE _____ AIR SPEED INDICATOR CALIBRATION DATE _____

TABLE I. Altimeter Scale Correction in feet to be added to Indicated Altitude to obtain Altimeter Corrected Altitude.

INDICATED ALTITUDE (FEET)	INSTRUMENT TEMPERATURE	
	HIGH °C	LOW °C
0		
500		
1000		
1500		
2000		
2500		
5000		
10000		
15000		
20000		
25000		
30000		
35000		
40000		
45000		
50000		

TABLE III. Conversion from Indicated Air Speed to Calibrated Air Speed in Miles Per Hour.

INDICATED AIR SPEED (MPH)	CALIBRATED AIR SPEED (MPH)	INDICATED AIR SPEED (MPH)	CALIBRATED AIR SPEED (MPH)
70		190	
80		200	
90		210	
100		220	
110		230	
120		240	
130		250	
140		260	
150		270	
160		280	
170		290	
180		300	

TABLE II Altimeter Installation Correction in Millibars to be added to Altimeter Pressure to obtain True Pressure

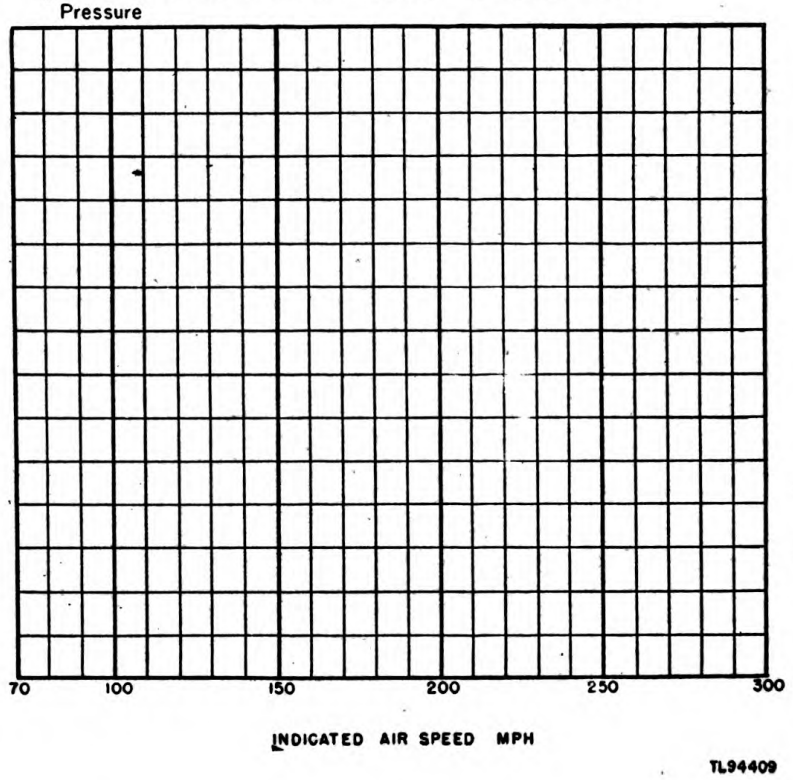

Figure 10. Correction sheet for Psychrometer Equipment ML-313/AM, front.

TABLE IV. Temperature Correction in Degrees Centigrade to be Subtracted from Indicated Dry Bulb Temperature to Obtain True Dry Bulb Temperature.

TRUE AIR SPEED (MPH)	0	1	2	3	4	5	6	7	8	9
70	.4	.4	.5	.5	.5	.5	.5	.5	.5	.5
80	.6	.6	.6	.6	.6	.6	.6	.7	.7	.7
90	.7	.7	.7	.8	.8	.8	.8	.8	.8	.9
100	.9	.9	.9	.9	.9	1.0	1.0	1.0	1.0	1.0
110	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2
120	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.5
130	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.7	1.7
140	1.7	1.7	1.8	1.8	1.8	1.8	1.9	1.9	1.9	1.9
150	2.0	2.0	2.0	2.0	2.1	2.1	2.1	2.1	2.2	2.2
160	2.2	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.5	2.5
170	2.5	2.5	2.6	2.6	2.6	2.7	2.7	2.7	2.8	2.8
180	2.8	2.9	2.9	2.9	3.0	3.0	3.0	3.0	3.1	3.1
190	3.1	3.2	3.2	3.2	3.3	3.3	3.3	3.4	3.4	3.5
200	3.5	3.5	3.6	3.6	3.6	3.7	3.7	3.7	3.8	3.8
210	3.8	3.9	3.9	4.0	4.0	4.0	4.1	4.1	4.1	4.2
220	4.2	4.3	4.3	4.3	4.4	4.4	4.4	4.5	4.5	4.6
230	4.6	4.6	4.7	4.7	4.8	4.8	4.9	4.9	4.9	5.0
240	5.0	5.1	5.1	5.1	5.2	5.2	5.3	5.3	5.4	5.4
250	5.4	5.5	5.5	5.6	5.6	5.7	5.7	5.8	5.8	5.8
260	5.9	5.9	6.0	6.0	6.1	6.1	6.2	6.2	6.3	6.3
270	6.3	6.4	6.4	6.5	6.5	6.6	6.6	6.7	6.7	6.8
280	6.8	6.9	6.9	7.0	7.0	7.1	7.1	7.2	7.2	7.3
290	7.3	7.4	7.4	7.5	7.5	7.6	7.6	7.7	7.7	7.8
300	7.8	7.9	7.9	8.0	8.0	8.1	8.2	8.2	8.3	8.3

TABLE V. Pressure Increment in Millibars to be Added to True Pressure to Obtain Psychrometer Effective Pressure.

CALIBRATED AIR SPEED (MPH)	0	1	2	3	4	5	6	7	8	9
70	5	5	6	6	6	6	6	6	7	7
80	7	7	7	7	8	8	8	8	8	8
90	9	9	9	9	9	10	10	10	10	10
100	11	11	11	11	12	12	12	12	12	13
110	13	13	13	14	14	14	14	15	15	15
120	15	16	16	16	17	17	17	17	18	18
130	18	18	19	19	19	20	20	20	20	21
140	21	21	22	22	22	23	23	23	24	24
150	24	25	25	25	26	26	26	27	27	27
160	28	28	28	29	29	29	30	30	30	31
170	31	32	32	32	33	33	33	34	34	35
180	35	35	36	36	37	37	37	38	38	39
190	39	40	40	40	41	41	42	42	43	43
200	43	44	44	45	45	46	46	46	47	47
210	48	48	49	49	50	50	51	51	52	52
220	53	53	54	54	55	55	56	56	57	57
230	58	58	59	59	60	60	61	61	62	62
240	63	63	64	65	65	66	66	67	67	68
250	68	69	70	70	71	71	72	72	73	74
260	74	75	75	76	77	77	78	78	79	80
270	80	81	81	82	83	83	84	85	85	86
280	86	87	88	88	89	90	90	91	92	92
290	93	94	94	95	96	96	97	98	98	99
300	100	100	101	102	103	103	104	105	105	106

TL94410

Figure 11. Correction sheet for Psychrometer Equipment ML-313/AM, back.

INDICATED ALTITUDE (FEET)	INSTRUMENT TEMPERATURE	
	HIGH 24 °C	LOW −32 °C
*	*	*
10,000	+40	+130
15,000	+100	+230
*	*	*

Find the altimeter scale correction for an indicated altitude of 13,000 feet and a cabin temperature of +10° C. Proceed as follows:

(a) The scale correction for a temperature of +24° C at an indicated altitude of 13,000 feet must lie between the corrections (at the same temperature) for 10,000 feet and 15,000 feet indicated altitude.

1. Correction for 15,000 feet at +24° C = +100 feet
   Correction for 10,000 feet at +24° C = +40 feet

   Difference = 60 feet

2. An increase of 5,000 feet in the indicated altitude results in an increase of 60 feet in the altimeter scale correction. An increase of 3,000 feet (from 10,000 to 13,000 feet) causes an increase of 3/5 of 60 or 36 feet. The altimeter scale correction for 13,000 feet at +24° C is, therefore, 40 + 36 or 76 feet.

(b) Determine the scale correction for a temperature of −32° C at an indicated altitude of 13,000 feet. This scale correction must lie between the corrections (at the same temperature) for 10,000 feet and 15,000 feet indicated altitude.

1. Correction for 15,000 feet at −32° C = +230 feet
   Correction for 10,000 feet at −32° C = +130 feet

   Difference = 100 feet

2. An increase of 5,000 feet in indicated altitude results in an increase of 100 feet in the altimeter scale correction. An increase of 3,000 feet (from 10,000 feet to 13,000 feet) causes an increase of 3/5 of 100 or 60 feet. The altimeter scale correction for 13,000 feet at −32° C is, therefore, 130 + 60 or +190 feet.

(c) Find the altimeter scale correction for an indicated altitude of 13,000 feet at +10° C. This value must lie between the corrections at 13,000 feet for +24° C and −32° C.

1. Correction for 13,000 feet at −32° C = +190 feet
   Correction for 13,000 feet at +24° C = +76 feet

   Difference = 114 feet

2. A decrease of 56° in temperature results in an increase of 114 feet in the altimeter scale correction. A decrease of 14° (from +24° C to +10° C) causes an increase of 14/56 or 1/4 of 114 feet. This increase is 28.5 feet. The altimeter scale correction for 13,000 feet indicated altitude and +10° C instrument temperature is 76 + 28.5 or +104.5 feet. Round off +104.5 to +104 feet.

c. Table II (fig. 10). (1) GENERAL. Table II provides a means of obtaining the altimeter installation correction in millibars to be added to the altimeter pressure to get the true pressure. Table II consists of a graph with indicated air speeds from 70 to 300 miles per hour plotted on the horizontal axis and altimeter installation corrections (in millibars) plotted on the vertical axis. The scale of values for the vertical axis is determined by the range of values obtained for the altimeter installation corrections as described in subparagraph (4) below. These values may be either positive or negative. Table II should never be omitted in determining atmospheric pressure from the altimeter even when table I has been omitted. Always use table II as a routine matter in computing pressure from the altimeter.

(2) PLOTTING POINTS ON GRAPH. To plot a point on the graph, two values, one for the indicated air speed and one for the altimeter installation correction, must be known. Thus, to locate on the graph the point determined by an indicated air speed of 220 miles per hour and by an altimeter installation correction of 5 millibars, proceed as follows:

(a) Locate 220 on the horizontal scale.

(b) Move vertically upward until the horizontal line which represents 5 millibars is reached. Mark this intersection as the point which is fixed by the given values.

(c) Join this point with a smooth curve to other points similarly plotted on the graph.

(3) READING GRAPH. Once the graph is drawn, the altimeter installation correction can be read directly from it if the indicated air speed is known.

(a) Find the value of the indicated air speed on the horizontal scale.

(b) Move vertically upward on the line representing the indicated air speed to its intersection with the curve.

(c) To the left of this intersection, on the vertical scale, read the altimeter installation correction to the nearest whole millibar.

(4) DETERMINING ALTIMETER INSTALLATION CORRECTIONS. The altimeter installation corrections may be computed in either of two ways.

(a) If possible, arrange to have the airplane flight calibrated by the Flight Test Section, Wright Field, Dayton, Ohio. If the data on the flight test is

given as a table of altimeter installation errors, then the corrections will have the opposite sign.

(b) If the airplane cannot be calibrated for altimeter installation correction at Wright Field, then make the necessary calibration as indicated in the subparagraphs below. This procedure for obtaining altimeter scale corrections is a practical and accurate method for use in the field, and is more complete than the procedure outlined in AAF TO No. 05–30–1.

1. Taxi the airplane to a convenient spot on the runway which can be identified from the air. With the airplane standing still, set the altimeter at 29.92. Tap the altimeter to eliminate possible errors due to friction, and record the altimeter's indicated altitude. If the atmospheric pressure is greater than 29.92 inches of mercury, the altimeter indicates an altitude of less than 0 feet. In this case the altimeter must be read with great care to interpret the reading correctly.
2. Fly the airplane over the runway at an estimated absolute height of 25 feet at intervals of 20 miles per hour indicated air speed throughout the safe speed range of the airplane.
3. Record the indicated altitude and indicated air speed each time the landmark on the runway is passed. Tap the altimeter a few times just before reading.
4. Immediately following the completion of the flight, taxi the airplane to the landmark on the runway and redetermine the altimeter's indicated altitude with the airplane standing still.
5. Add algebraically to each observation the proper altimeter scale correction.
6. Average the readings of the altimeter (corrected for scale error) on the runway before and after the test, and add algebraically this average value to the elevation of flight above the landmark (25 feet). This gives the pressure altitude at the level of flight.
7. Subtract algebraically the indicated altitude (corrected for scale error) obtained at each indicated air speed from the pressure altitude obtained in subparagraph 6 above. Tabulate the differences for each indicated air speed.
8. The values obtained in subparagraph 7 above are the altimeter installation corrections in feet and apply only to the pressure level at which the test was made. To change these corrections in feet to corrections in millibars, which are applicable at any flight level, *change their sign* and multiply them

by	*if the elevation obtained in subparagraph 6 above is between*
0.037	–800 and 100 feet
0.036	100 and 1,000 feet

0.035	1,000 and 1,900 feet
0.034	1,900 and 2,900 feet
0.033	2,900 and 3,900 feet
0.032	3,900 and 5,000 feet
0.031	5,000 and 6,100 feet
0.030	6,100 and 7,200 feet
0.029	7,200 and 8,300 feet
0.028	8,300 and 9,400 feet

9. Plot the resulting values on the vertical axis of the graph (table II) against their corresponding indicated air speeds, and draw a smooth curve through the points. From this curve, the altimeter's installation correction for any indicated air speed may be determined.

d. Table III (fig. 10). (1) GENERAL. Table III consists of four columns labeled alternately Indicated Air Speed and Calibrated Air Speed. The indicated air speeds from 70 to 300 miles per hour are listed in the column labeled Indicated Air Speed. Obtain the values for the Calibrated Air Speed column from the Airspeed Calibration Card (AAF Form No. 21E, Class 30B), which is often posted on the instrument panel near the air speed indicator. The Airspeed Calibration Card is prepared as a result of a flight calibration.

(2) DETERMINING CORRECTIONS FOR AIR SPEED INDICATOR. If a flight calibration has not been made and the Airspeed Calibration Card has not been prepared for an airplane, obtain tentatively the data for table III from the air speed calibration chart which is issued in blue print form with all new models of airplanes. Since these data are approximations only and are not accurate for any individual airplane or air speed indicator installation, table III when completed with them should be marked *Tentative.* Accurate data for completing table III may be obtained from a calibration flight test made by the Flight Test Section, Wright Field, Dayton, Ohio, or from a flight made according to the procedure outlined in AAF TO No. 05–20–8, Handbook of Instructions, Calibration of Airspeed Indicator Installations, section II.

(3) ALTERNATIVE METHOD FOR FINDING AIR SPEED INDICATOR CORRECTIONS. An alternative to the flight calibration of subparagraph (2) above is possible because of the close relationship between the installation corrections in millibars for the pressure altimeter and the calibration corrections in miles per hour for the air speed indicator attached to the same static tube installation. It uses data taken during the flight to determine the altimeter installation correction, and furnishes results for the air speed indicator correction with accuracy equivalent to that obtained by the standard speed course procedure with a considerable saving in time for flying and in time for making computations.

(a) Formula. To determine the corrections from indicated to calibrated air speed by the alternative method, use the formula

$$\triangle v_i = - \frac{10^3 \triangle p}{2.45\ v_i}$$

In the formula, $\triangle v_i$ is the number of miles per hour to be added algebraically to the indicated air speed (v_i) to give the corresponding calibrated air speed; $\triangle p$ is the altimeter installation correction in millibars found in paragraph **c** (4) **(b)** 8 above and is used to complete table II; and v_i is the indicated air speed in miles per hour for which $\triangle p$ has been determined and $\triangle v_i$ is desired.

(b) Example. Assume that the altimeter calibration flight gives the following data:

indicated air speed (v_i) = 170 miles per hour,
altimeter installation correction = −2.8 millibars.

Substituting in the formula of subparagraph **(a)** above

$$\triangle v_i = - \frac{1{,}000 \times (-2.8)}{2.45 \times 170} = \frac{2{,}800}{416.5} = 6.7 \text{ mph}$$

NOTE: Other sets of data taken during the altimeter calibration flight can be treated as in subparagraph **(b)** above. If the algebraic sign of $\triangle v_i$ is negative, the conversion from the indicated to calibrated air speed is accomplished by subtraction.

(4) WHEN TO USE TABLE III. The conversion from indicated to calibrated air speed is a refinement in the procedure for obtaining true air speed. Any error which is introduced in the value of the true air speed is reflected in the accuracy of the true temperature determination. If the difference between the indicated air speed and calibrated air speed is 5 miles per hour and the conversion is ignored, an error of approximately 0.1° C to 0.25° C results in the temperature correction if the flight is at sea level pressure. An error of 0.25° C to 0.5° C results if the flight is made at 300 millibars (approximately 30,000 feet). Therefore, always perform the conversions of table III as a routine procedure in determining true air speed.

NOTE: In general, the instrumental error of an air speed indicator is extremely small and changes slowly. If there are no alterations in the pitot-static tube, the installation error should not change. Therefore, it is impossible to recommend a definite recalibration period for the air speed indicator. If, however, the pitot-static tube is damaged or disturbed in any manner or if the air speed indicator is changed, then the installation must be recalibrated. Leaks in the pitot-static line cause most of the installation error. Check carefully for this source of error in regularly scheduled service tests of the airplane.

e. Table IV (fig. 11). Table IV (par. 33) is a table of temperature corrections to be subtracted from indicated dry-bulb temperatures to obtain true dry-bulb temperatures. These corrections are a function of the true air speed. In table IV, true air speeds ranging from 70 to 300 miles per hour by intervals of 10 miles per hour are listed in the vertical column. The intervals of 10

miles per hour are further subdivided into smaller intervals of 1 mile per hour in a horizontal row of column headings labeled 0 to 9. Temperature corrections corresponding to any whole mile-per-hour value of true air speed between 70 and 309 miles per hour can be determined from this table without interpolation. Use table IV whenever Psychrometer Equipment ML–313/AM is used in flight to determine the true air temperature at the level of flight or the true humidity of the air. Determine the true air speed to the nearest mile per hour at the moment of reading the dry-bulb thermometer, and enter the table with this value. Thus, to find the temperature correction corresponding to a true air speed of 175 miles per hour, proceed as follows:

(1) The value 175 equals 170 + 5. Find the value 170 in the vertical column.

(2) To the right of 170, in the column headed 5, find the value 2.7. The desired temperature correction is therefore 2.7° C.

(3) To find the true dry-bulb temperature, subtract the temperature correction (2.7° C) from the indicated dry-bulb temperature.

f. Table V (fig. 11). Table V (par. 34) is used to determine the pressure increment to be added to the true pressure to obtain the effective pressure. The effective pressure is the pressure which occurs at the point of temperature measurement in the ventilator of the psychrometer. Although the pressure increments are a function of the indicated air speed, they are given in table V as a function of calibrated air speed because the calibrated air speed is the indicated air speed corrected for instrumental and installation errors of the air speed indicator installation. In table V, the calibrated air speeds ranging from 70 to 300 miles per hour are listed in steps of 10 in the vertical side column. The steps of 10 are further subdivided into divisions of 1 mile per hour in a horizontal row of column headings labeled from 0 to 9. Pressure increments corresponding to any whole mile-per-hour value of calibrated air speed from 70 to 309 miles per hour can be read from the table without interpolation. Use table V whenever observations are made in flight with Psychrometer Equipment ML–313/AM to determine the humidity of the air at the level of flight. Proceed as follows:

(1) Determine the calibrated air speed to the nearest mile per hour at the moment of reading the thermometer.

(2) Enter table V with the value of calibrated air speed, and find the corresponding pressure increment.

(3) Add the pressure increment to the true pressure (as determined from the airplane's altimeter) to obtain the effective pressure.

17. USE OF CALCULATORS.

a. Pressure Calculator ML-323/UM. The pressure calculator is used as an intermediate step to obtain the true pressure from the indications of the airplane's altimeter. The pressure calculator converts pressure altitude in feet to the corresponding pressure in millibars. The side of the calculator to use

for any given conversion is determined by the altitude. The face side of the calculator includes altitudes from −1,000 feet to +23,000 feet. The reverse side covers altitudes ranging from 21,000 feet to 45,000 feet.

b. Air Speed Calculator ML-324/UM. The air speed calculator is used as an intermediate step in the determination of the dynamic temperature correction which is a function of the true air speed. This calculator converts the calibrated air speed to true air speed.

c. Psychrometric Calculator ML-322/UM. The psychrometric calculator is used to obtain the true relative humidity, dew point, and vapor pressure. Only the centigrade-millibar side of the psychrometric calculator is used with Psychrometer Equipment ML–313/AM.

18. CALCULATING AND RECORDING DATA.

The computation of true temperature, relative humidity, dew point, and vapor pressure requires the use of tables I through V, Psychrometric Calculator

S.C. FORM NO. 421 PSYCHROMETER EQUIPMENT ML-313/AM FLIGHT DATA AND COMPUTATION SHEET

Date 29 OCT 44 Station MITCHEL FIELD Pilot LT. JOHN DOE

Airplane B-25G 42-65131 Observer SGT. R. ROE

Flight Plan

TIME	1400	1530											
ALTIMETER SETTING	29.34	30.42											
INDICATED ALTITUDE	10,340	15,000											
CORRECTED ALTITUDE	10,468	15,162											
ALTIMETER PRESSURE	670	579											
TRUE PRESSURE	673	5[illegible]7											
INDICATED AIR SPEED	185	200											
CALIBRATED AIR SPEED	191	207											
TRUE AIR SPEED	231	265											
INDICATED DRY BULB TEMPERATURE	7.42	-5.58											
TEMPERATURE CORRECTION	4.6	6.1											
TRUE DRY BULB TEMPERATURE	2.8	-11.7											
PRESSURE INCREMENT	40	46											
EFFECTIVE PRESSURE	713	623											
INDICATED WET BULB TEMPERATURE	3.92	-8.38											
INDICATED WET BULB DEPRESSION	3.50	2.80											
TRUE RELATIVE HUMIDITY	81	77											
TRUE DEW POINT	-0.1	-14.6											
TRUE VAPOR PRESSURE	6.07	1.71											TL 94414

Figure 12. Psychrometer Equipment ML–313/AM Flight Data and Computation Sheet with Sample Entries.

ML–322/UM, Pressure Calculator ML–323/UM, and Air Speed Calculator ML–324/UM. The tables all appear on Signal Corps Form No. 400, Correction Sheet for Psyychrometer Equipment ML–313/UM. Record all data on Signal Corps Form No. 421, Psychrometer Equipment ML–313/AM Flight Data and Computation Sheet (fig. 12). Perform all calculations in the order and manner indicated below.

a. Entry of Observed Data. Enter the following simultaneously observed data in Psychrometer Equipment ML–313/AM Flight Data and Computation Sheet:

(1) Time of observation.

(2) Altimeter setting.

(3) Indicated altitude as read from the airplane's pressure altimeter.

(4) Indicated air speed.

(5) Indicated dry-bulb temperature.

(6) Indicated wet-bulb temperature.

(7) Indicated wet-bulb depression (difference between the dry-bulb and wet-bulb temperatures).

NOTE: Estimate the indicated dry-bulb and wet-bulb temperatures to hundredths of a degree centigrade for the purpose of determining the wet-bulb depression. In all other computations, use the indicated dry-bulb and wet-bulb temperatures to the nearest tenth of a degree centigrade.

b. Calculation of True Pressure.

(1) Find the altimeter scale correction in table I (par. 16**b**). Add the altimeter scale correction algebraically to the indicated altitude to determine the corrected altitude.

(2) Use Pressure Calculator ML–323/UM to determine the altimeter pressure. Set the arrow to the observed altimeter setting and read the altimeter pressure on scale A opposite the corrected altitude on scale B.

(3) Use table II to find the altimeter installation correction (par. 16**c**). Add the altimeter installation correction algebraically to the altimeter pressure to determine the true pressure.

c. Calculation of True Air Speed.

(1) Use table III to determine the calibrated air speed corresponding to the indicated air speed (par. 16**d**).

(2) Use Air Speed Calculator ML–324/UM to determine the true air speed. Set the indicated dry-bulb temperature on scale A opposite the true pressure on scale B. Read the true air speed on scale D opposite the calibrated air speed on scale C.

NOTE: A more accurate value of the true air speed is obtained if the true temperature of the free air is known and is set on scale A. A good approximation to use for this setting is obtained by subtracting 4° from the indicated

dry-bulb temperature. Still greater accuracy can be obtained in determining true air speed by taking into account the compressibility factor. This can be done with the use of AAF True Airspeed Computor, Type AN 5836-1, described in TO 05-35-32, or Type G-1, described in TO 05-35-17. The effect of compressibility, however, on the determination of true temperature and true humidity from aircraft observations can be neglected at true air speeds of 250 miles per hour or less and at altitudes not exceeding 30,000 feet.

d. Calculation of True Dry-bulb Temperature.

(1) Use table IV to determine the temperature correction (par. 16**e**).

(2) Determine the true temperature by subtracting algebraically the temperature correction from the indicated dry-bulb temperature.

e. Calculation of True Relative Humidity, True Dew Point, and True Vapor Pressure.

(1) In table V, use the calibrated air speed and read the corresponding pressure increment (par. 16**f**).

(2) Determine the effective pressure by adding the pressure increment to the true pressure.

(3) Use the centigrade-millibar side of Psychrometric Calculator ML–322/UM to determine the true relative humidity, the true dew point, and the true vapor pressure. Proceed as follows:

(a) Set the indicated wet-bulb temperature on the t' scale against the indicated wet-bulb depression on the $t - t'$ scale.

(b) Move the hairline to the value of the effective pressure on the P scale, and read the value indicated under the hairline on the C_1 scale.

(c) Move the hairline to the value on the C_2 scale equal to the value read from the C_1 scale in subparagraph **(b)** above.

(d) Hold the hairline fixed with respect to the large disk, and move the small disk to bring the effective pressure on the P scale under the hairline.

(e) Move the hairline to the value of the true pressure on the P scale.

(f) Hold the hairline fixed with respect to the large disk, and move the small disk to bring the value of the indicated wet-bulb temperature on the Θ scale under the hairline.

(g) Move the hairline on the Θ scale to the value of the true dry-bulb temperature, and read the true relative humidity in percent on the C_2 scale.

(h) Move the hairline to the index arrow, and read the true dew point temperature on the DP scale and the true vapor pressure on the VP scale.

NOTE: The directions given above for the calculation of true relative humidity, true dew point, and true vapor pressure are simpler than the directions printed on the face of Psychrometric Calculator ML–322/UM and eliminate a

few steps. To follow the printed directions, first find the relative humidity in the psychrometer ventilator by using the indicated psychrometer temperatures and effective pressure. Then convert the ventilator humidity (RH_1) at effective pressure (P_1) and indicated dry-bulb temperature (t_1) to true relative humidity (RH_2) at true pressure (P_2) and true dry-bulb temperature (t_2) by following the second set of directions on the calculator. Then move the hairline to the index arrow to read the true dew point temperature on the DP scale and the true vapor pressure on the VP scale.

19. ILLUSTRATIVE EXAMPLE IN COMPUTING DATA.

The following example illustrates the method for obtaining values of true temperature, relative humidity, dew point, and vapor pressure from the indications of the airplane's altimeter and air speed indicator and from Psychrometer Equipment ML–313/AM.

a. Observed Data. Assume the following observed data:

(1) Altimeter setting = 29.34 in. of mercury
(2) Indicated altitude = 10,340 feet
(3) Indicated air speed = 185 mph
(4) Indicated dry-bulb temperature = 7.42° C
(5) Indicated wet-bulb temperature = 3.92° C
(6) Indicated wet-bulb depression = 3.50° C

b. Calculation of True Pressure.

(1) Assume the flight is made in a medium bomber and that the cabin (and altimeter instrument) temperature is 15° C. Table I gives the following data:

INDICATED ALTITUDE (FEET)	INSTRUMENT TEMPERATURE	
	HIGH 20° C	LOW −35° C
*	*	*
10,000	+140	−24
15,000	+168	+102
*	*	*

(a) The computations are as follows:

1. Correction for 15,000 feet at +20° C = +168 feet
   Correction for 10,000 feet at +20° C = +140 feet
   Difference = + 28 feet
2. An increase of 340 feet (10,340 − 10,000) causes an increase of 340/5,000 × 28 or 1.9. Round off 1.9 to 2 feet.
   140 + 2 = 142 (altimeter scale correction for 10,340 feet at 20° C)

3. Correction for 15,000 feet at −35° C = +102 feet
   Correction for 10,000 feet at −35° C = −24 feet

   Difference = 126 feet

4. An increase of 340 feet causes an increase of 340/5,000 × 126 or 8.6. Round off 8.6 to 9.
   (−24) + 9 = −15 (altimeter scale correction for 10,340 feet at −35° C)

5. Correction for 10,340 feet at 20° C = +142 feet
   Correction for 10,340 feet at −35° C = −15 feet

   Difference = 157 feet

6. A decrease of 5° (20° − 15°) causes a decrease of 5/55 or 1/11 of 157, or 14.3. Round off 14.3 to 14.
   142 − 14 = 128 feet (altimeter scale correction for 10,340 feet at 15° C)

(b) Add the scale correction to the indicated altitude to obtain the corrected altitude.

10,340 + 128 = 10,468 feet

(2) Set the arrow on Pressure Calculator ML–323/UM to 29.34 (inches of mercury), and convert 10,468 feet corrected altitude to 670 millibars altimeter pressure.

(3) Assume the altimeter installation correction for an indicated air speed of 185 miles per hour to be 3.2 millibars as read from table II. Round off 3.2 to 3 millibars.

Altimeter installation correction + altimeter correction = true pressure

3 + 670 = 673 millibars

c. Calculation of True Air Speed.

(1) Assume that a calibrated air speed of 191 miles per hour corresponds to the indicated air speed of 185 miles per hour (table III).

(2) On Air Speed Calculator ML–324/UM, set the indicated dry-bulb temperature of 7.4° C on scale A against the true pressure of 673 millibars on scale B, and read the true air speed of 231 miles per hour on scale D against the calibrated air speed of 191 miles per hour on scale C.

d. Calculation of True Dry-bulb Temperature.

(1) In table IV, use a true air speed of 231 miles per hour. Read a temperature correction of 4.6° C.

(2) Indicated dry-bulb temperature − temperature correction = true dry-bulb temperature.

7.4° C − 4.6° C = 2.8° C

e. Calculation of True Relative Humidity, True Dew Point, and True Vapor Pressure.

(1) In table V, use a calibrated air speed of 191 miles per hour, and find a pressure increment of 40 millibars.

(2) Pressure increment + true pressure = effective pressure

40 + 673 = 713 millibars

(3) Use the centigrade-millibar side of Psychrometric Calculator ML–322/UM as follows:

(a) Set 3.9° (indicated wet-bulb temperature) on the t' scale against 3.5° (indicated wet-bulb depression) on the t – t' scale.

(b) Set the hairline on 713 millibars (effective pressure) on the P scale, and read 79.5 on the C_1 scale.

(c) Move the hairline to 79.5 on the C_2 scale.

(d) Hold the hairline fixed, and move the small disk to bring 713 millibars on the P scale under the hairline.

(e) Move the hairline to 673 millibars (true pressure) on the P scale.

(f) Hold the hairline fixed with respect to the large disk, and move the small disk to 3.9° (indicated wet-bulb temperature) on the Θ scale under the hairline.

(g) Move the hairline to 2.8° (true dry-bulb temperature) on the Θ scale, and read 81 percent (read to the nearest whole percent) on the C_2 scale. The true relative humidity is therefore 81 percent.

(h) Move the hairline to the index arrow on the Θ scale, and read 0.1° C dew point temperature on the DP scale and a vapor pressure of 6.07 millibars on the VP scale.

20. EQUIPMENT PERFORMANCE CHECK LIST.

	Item No.	Item	Action or condition	Normal indication	Corrective measure
PREPARATORY	1	Wick.	Boil in proper caustic or soap solution. Wash in boiling distilled water.	Wick is not frayed or otherwise damaged.	Do not overboil or use too strong a caustic solution.
	2	Wick.	Tie the dry wick on the bulb of the wet - bulb thermometer.	Wick fits snugly on the bulb.	Stretch wick until it fits tightly.
	3	Wire guard.	Secure a thermometer guard over the bulb of the wet-bulb thermometer.	Pressure seal is provided around thermometer bulb.	Replace the rubber bearing with a new one.
	4	Altimeter.	Before take - off, record the altimeter setting.		
	5	Thermometer.	Read the temperature indication of each thermometer in the psychrometer support.	Both thermometers indicate the same temperature.	Refer to paragraph 13*j* and *k*.
	6	Wet-bulb thermometer.	Lower the bulb of the wet - bulb thermometer into the bottle of distilled water, and wet the wick.	Dry-bulb thermometer does not get wet.	Secure a wire guard over each bulb. The lower thermometer is always the wet-bulb thermometer.
	7	Ventilator cover.	Loosen the wing-nuts and remove the ventilator cover.	Ventilator tube opening is exposed.	
	8	Psychrometer support.	Insert support into ventilator tube and lock flange into position.	Support is held in upright position.	

20. EQUIPMENT PERFORMANCE CHECK LIST—(contd).

	Item No.	Item	Action or condition	Normal indication	Corrective measure
EQUIPMENT PERFORMANCES	9	Psychrometer.	Read thermometers after 2 minutes of level flight. Record readings when wet-bulb thermometer indicates lowest temperature.	Wet-bulb depression is at a maximum.	Refer to paragraphs 14*b*(1), (2).
	10	Air speed indicator.	Record the indicated air speed.		
	11	Altimeter.	Record the indicated altitude. Record any change in altimeter setting made during flight.		
	12	Watch.	Record the time at which the readings are taken.		
STOP	13	Tables and calculators.	Compute relative humidity, dew point, and vapor pressure.		
	14	Psychrometer support.	Loosen wingnuts and remove psychrometer support. Replace the support in the carrying case.	The support is securely held in place by lift-o-dot fasteners.	
	15	Ventilator cover.	Secure the ventilator cover over the ventilator-tube opening.	The keyhole slots fit under the tightened wingnuts.	Tighten the wingnuts.

PART THREE
PREVENTIVE MAINTENANCE

SECTION V
PREVENTIVE MAINTENANCE TECHNIQUES

21. MEANING OF PREVENTIVE MAINTENANCE.

Preventive maintenance may be defined as a systematic series of operations performed periodically on equipment in order to maintain top efficiency in performance, to minimize unwanted interruptions in service, and to eliminate major break-downs. To appreciate the meaning of the term *preventive maintenance,* it is necessary to distinguish between preventive maintenance and trouble shooting and repair. The primary function of preventive maintenance is to prevent major break-downs and the consequent necessity of repair. In sharp contrast, the primary function of trouble shooting and repair is to locate and correct existing defects. The importance of preventive maintenance cannot be overemphasized. The usefulness of an entire meteorological system depends upon each piece of meteorological equipment in the system being ready to operate at peak efficiency when needed. Consequently, it is vitally important that operators and repairmen of meteorological equipment maintain their equipment properly.

NOTE: The operations in section VI are considered first and second echelon (organization operators and repairmen) maintenance.

22. DESCRIPTION OF PREVENTIVE MAINTENANCE TECHNIQUES.

(a) Most of the parts of any meteorological equipment require routine preventive maintenance. Those requiring maintenance differ in the amount and kind required. The six basic maintenance operations are as follows: FEEL, INSPECT, TIGHTEN, CLEAN, ADJUST, and LUBRICATE. The following lettering system has been adopted for the six basic operations:

F — Feel
I — Inspect
T — Tighten
C — Clean
A — Adjust
L — Lubricate

The first two operations establish the need for the other four. The selection of operations is based on a general knowledge of field requirements. Field use of any meteorological equipment without continuous preventive maintenance

will result in the equipment becoming operationally erratic, undependable, and subject to break-down when most needed.

(b) Psychrometer Equipment ML–313/AM requires only routine inspection, cleaning, and tightening. Section VI treats the individual parts requiring maintenance.

SECTION VI
PREVENTIVE MAINTENANCE

23. COMMON MATERIALS.

Have the following items on hand before beginning maintenance work: screwdriver, knife or other cutting tool, and clean, dry cloths or tissue.

24. PREVENTIVE MAINTENANCE CHECK LIST.

The following check list shows a suggested schedule for performing preventive maintenance on Psychrometer Equipment ML–313/AM. More frequent scheduling of operations due to unusual operating conditions is left to the discretion of the person in charge. The echelon column shows the echelons recommended for performing the operations.

Item No.	Operation	Description	When performed		Echelon
			Daily	Monthly	
1	ICT	Thermometers (par. 25)	X		1
2	Replace	Wick (par. 26)	X		1
3	IC	Psychrometer support (par. 27)	X		1
4	IC	Ventilator (par. 28)		X	1

F	I	T	C	A	L
Feel	Inspect	Tighten	Clean	Adjust	Lubricate

25. THERMOMETERS.

a. Inspection (I). Inspect the thermometers for chips, cracks, or breaks. Replace any damaged glass part (par. 31**a**).

b. Cleaning (C). Do not allow dust or any other foreign material to accumulate on the bulbs. Use a very soft tissue or a clean, dry cloth to wipe the glass clean.

c. Tightening (T). Tighten all nuts and screws which help to hold the glass parts in place and which protect them.

d. Miscellaneous. (1) Handle the thermometers with the care necessary for any fragile glass instrument.

(2) Keep the thermometers in their carrying case at all times that they are not in use.

(3) When taking readings, use only clean water on the wet-bulb thermometer, preferably distilled or rain water free of all mineral matter. Keep the water in the small capped bottle. During freezing weather keep this water supply at temperatures above freezing.

(4) To remove a drop of mercury that is lodged in the expansion chamber after the thermometer has been exposed to temperatures above its upper range, slap the sides of the support firmly until the mercury is dislodged.

(5) To join a split column of mercury in the stem of a thermometer, gently warm the thermometer bulb by inserting it in warm water or by holding it before the cabin heater until the mercury below the break flows into the expansion chamber at the top of the stem. Then cool the bulb slowly, tapping the support to prevent any globules of mercury from adhering to the walls of the expansion chamber.

26. CARE OF WICK.

Put a new clean wick on the wet-bulb thermometer *each day that the thermometer is used.* Keep the wick free from dust and other foreign matter to prevent serious errors in the operation of the thermometer. Keep extra thread and wicking in the compartments provided for them in the carrying case.

27. PSYCHROMETER SUPPORTS.

a. Inspection (I). Inspect the psychrometer support for dents or other damages. Do not attempt to repair a damaged support. Replace it with a new one.

b. Cleaning (C). Rough gray spots on the psychrometer support are often caused by the oxidation of the aluminum. To remove these spots, proceed as follows:

(1) Remove the thermometers (par. 31**a**).

(2) Rub the aluminum with a soft cloth which has been soaked in a solution of sodium bicarbonate (ordinary baking soda). Never use acid solutions or abrasives to clean aluminum.

(3) Replace the thermometers (par. 31**a**).

28. CARE OF VENTILATOR.

a. Inspection (I). (1) Inspect the ventilator periodically to make sure that it remains firmly mounted on the airplane. Make sure that the inner faceplate remains even and flush with the ventilator tube. A well-installed ventilator requires very little attention. If the ventilator is not firmly mounted or if the inner faceplate is not flush with the ventilator tube, proceed as in paragraph 10**h** and **i**.

(2) Inspect the ventilator for dents. If the ventilator is dented or damaged

during unpacking, installation, or operation, do not try to repair it. Order a new ventilator and install it (par. 10).

(3) Inspect the ventilator for water which may collect in it when the airplane passes through rain or clouds. This water causes serious errors in the readings until the ventilator dries. Allow sufficient time for the inside of the ventilator to dry. Observations made while the ventilator is drying show an increasing wet-bulb depression.

b. Cleaning (C). Keep the aluminum ventilator clean and polished. Refer to paragraph 27**b** (2).

SECTION VII
LUBRICATION

NOTE: No lubrication is required for Psychrometer Equipment ML-313/AM.

SECTION VIII
MOISTUREPROOFING AND FUNGIPROOFING

NOTE: Moistureproofing and fungiproofing are not required for Psychrometer Equipment ML-313/AM.

PART FOUR
AUXILIARY EQUIPMENT

(NOT USED)

PART FIVE
REPAIR INSTRUCTIONS

NOTE: Failure or unsatisfactory performance of equipment used by Army Air Forces will be reported on Army Air Forces Form No. 54 (unsatisfactory report).

SECTION IX
THEORY OF EQUIPMENT

29. DESIGN OF PSYCHROMETER EQUIPMENT ML-313/AM.

a. Thermometers. Psychrometer Equipment ML–313/AM uses special thermometers with a right angle bend in each stem. The thermometer bulbs extend into the air stream outside the cabin of the airplane while the graduated portions of the stems are exposed inside the cabin without materially obstructing cabin space. A mercury-in-glass thermometer is the only simple temperature-measuring device with the desired accuracy and is, therefore, used with the psychrometer equipment. Each thermometer is individually calibrated and graduated (in steps of 0.1° C) to meet a specification tolerance which allows a maximum error not greater than 0.1° C at any point. The great majority of points on the scale are accurate to within 0.05° C. Two sets of thermometers covering a total range from –35° C to +50° are provided to accommodate any temperature condition. A single thermometer covering the complete range would be too long and too fragile for field use.

b. Psychrometer Support. The psychrometer support is designed to hold the thermometer bulbs in the air passing through the ventilator duct and to expose the thermometer scales within the airplane. The support clamps are made of transparent lucite to enable the thermometers to be read along the entire scale. A rubber gasket attached to the flange on each support and rubber bearings inserted in the sockets for the wire thermometer guards effect a pressure seal between the support and the ventilator when the two components are locked together. Tightening the wire guards makes the pressure seal between the thermometer stems and the psychrometer support; fastening the wingnuts on the inner faceplate of the ventilator over the keyhole slots in the flange of the psychrometer support completes the pressure seal. The psychrometer support is made retractable from the ventilator in order to allow dipping of the wet bulb. This provision makes possible the use of the psychrometer under

freezing temperatures by insuring a complete ice coating on the wet-bulb wick (par. 14**c**(3)).

c. Ventilator (fig. 13). (1) The outer shell of the ventilator is streamlined to offer minimum resistance to the air flow. The streamlined supporting strut which connects the outer faceplate of the ventilator to the outer shell prevents turbulence in the field of the ventilator. Turbulence would be critical if a cylindrical tube instead of a streamlined strut projected out from the airplane. The outer shell of the airplane serves as a radiation shield and is highly polished in order to reflect radiant heat.

(2) The inner duct provides ventilation to the thermometer bulbs and is designed in the form of a double cone with the forward section having a 7° flare. This design permits approximately laminar airflow through the duct to the point where the thermometers are placed and the temperature measured.

(3) The space between the outer shell and the inner duct is ventilated by air in order to carry away heat which may be absorbed by the outer shell. The air passes into the space through eight small holes in the nose of the ventilator and out through eight holes in the tail.

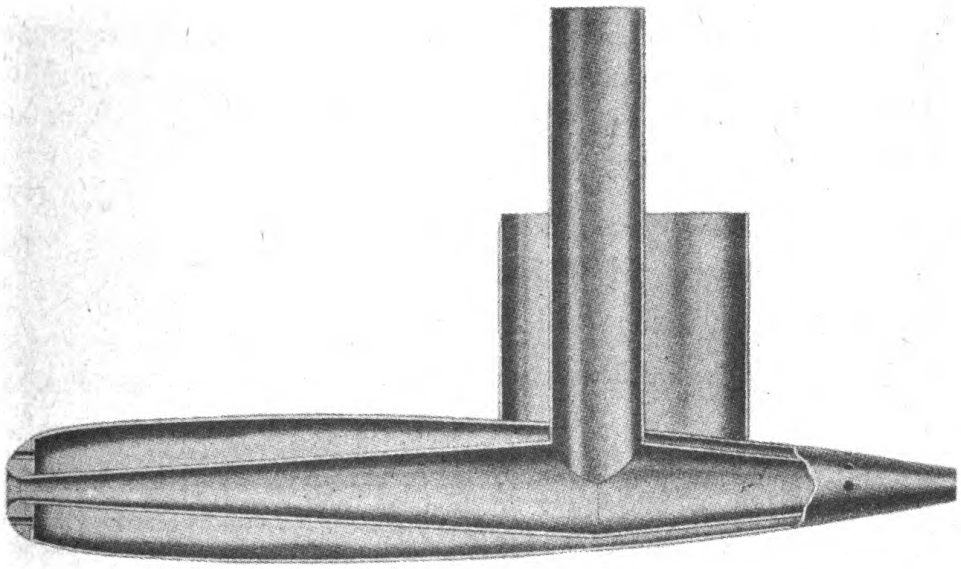

Figure 13. Ventilator, cross-section.

30. FUNCTIONING OF PARTS.

a. Psychrometer. The dry-bulb thermometer indicates the air temperature while the wet-bulb thermometer gives a somewhat lower temperature. In a stream of air, the wet bulb is subjected to an interchange of heat. Heat is supplied to the thermometer by the air stream, while heat is removed from the thermometer by vaporization of the water on the wet bulb. When the heat supplied by the air stream is equal to the heat removed by evaporation, a state of equilibrium is reached. The reading at this time is the wet-bulb tempera-

ture. It is assumed that the air in contact with the wet bulb becomes saturated at the wet-bulb temperature. By means of a psychrometric formula, provided the atmospheric pressure is known, the wet-bulb and dry-bulb temperatures can be converted into vapor pressure, dew point, or relative humidity, which are expressions for the humidity of the air.

b. Ventilator. (1) The ventilator shields the thermometers from radiational heating and reduces the velocity of air striking the psychrometer bulbs. The former purpose is accomplished by the double wall construction of the ventilator (par. 29**c**(2) and (3)). The design of the inner duct causes the reduction in velocity. The cross-sectional area at the point where the thermometers are placed is larger than the cross-sectional area of the entrance to the duct. The ratio of the cross-sectional areas is such that the free air velocity in the range from 102 to 330 miles per hour is reduced to 14 to 42 miles per hour at the thermometers. These latter velocities are in keeping with the ventilation generally provided for psychrometers. The decrease in air velocity prevents the wick on the wet bulb from drying before a maximum depression can be reached when the wet-bulb temperature is low. An increase in pressure accompanies the decrease in velocity. This pressure increase affects the humidity indication of the psychrometer, and requires corrections to be introduced into the humidity computations to obtain a value for the humidity of the free air.

(2) The pressure seal between the psychrometer support and the ventilator is necessary to insure a definite relationship between the pressure in the ventilator and the velocity of the airplane.

SECTION X
REPAIR

31. GENERAL REPAIR AND REPLACEMENT OF PARTS.

a. Replacing Broken Thermometer (fig. 14). (1) Unscrew the wire guard a few turns.

(2) Loosen the screws on the slotted sides of the lucite clamps.

(3) Raise the clamps to free the thermometer, and remove the glass pieces.

(4) Hold the new thermometer near the right-angle bend with one hand and slip the thermometer into place. Be careful not to cause any strain at the right-angle bend.

(5) Return the slotted clamps to their original positions.

(6) Tighten the screws until there is an equal pressure on both thermometers.

(7) Tighten the wire thermometer guard by tightening the knurled nut.

b. Bearings and Cushions. Replace all rubber bearings and thermometer cushions which have become worn or hardened with heat. Be sure that there is a perfect pressure seal around the thermometers; otherwise incorrect readings will result.

c. Rubber Gasket. Remove a damaged rubber gasket from the psychrometer support, and cement a new gasket in place. A tight pressure seal is necessary for accurate results.

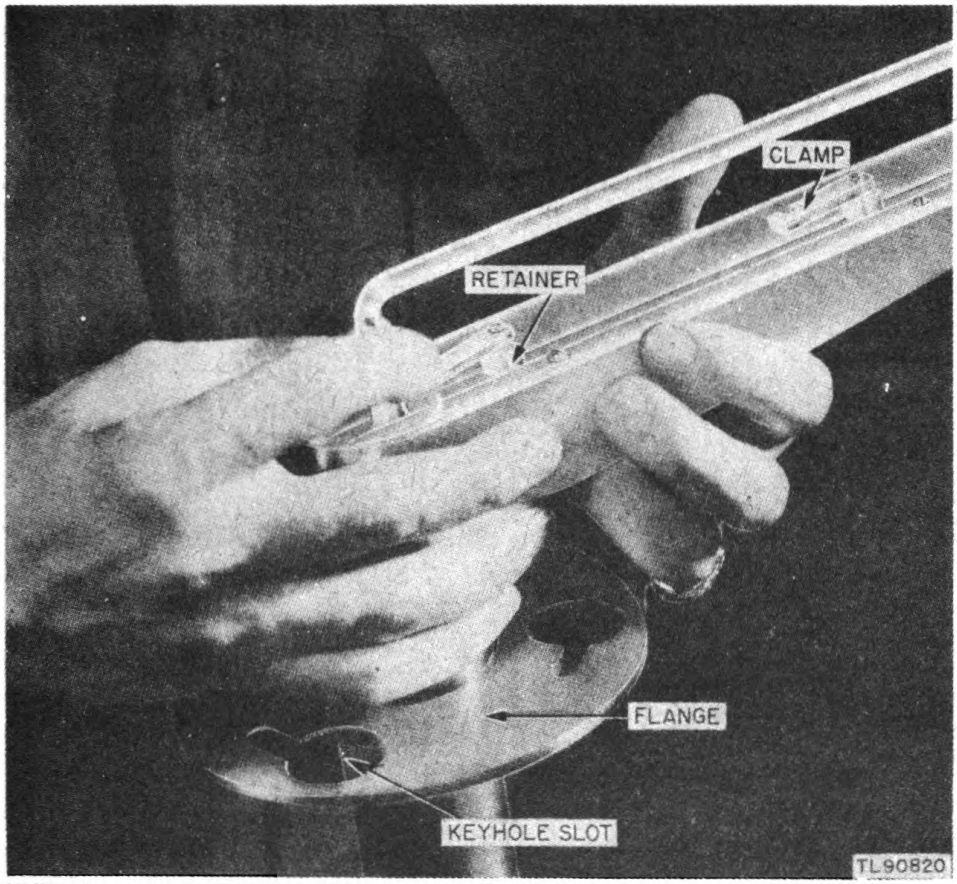

Figure 14. Thermometer replacement.

APPENDIX

SECTION XI MAINTENANCE PARTS

32. MAINTENANCE PARTS FOR PSYCHROMETER EQUIPMENT ML-313/AM.

Ref figure	Signal Corps stock No.	Name of part and description	Quan per unit	Running spares	Station stock	Region stock
2 ⑪	7A1322-313/B1	**BEARING:** synthetic rubber; 9/16″ OD x 1¼″ ID x 3/8″ thk; used as support and shock mounting for thermometer; (p/o Psychrometer Equipment ML-313/AM).	2	12	*	*
2 ⑫	6Z1012	**BOTTLE,** glass: 2-oz; straight, walled; 1 3/16″ ID x 1½″ OD x 3¼″ h; clear; flint glass, transparent; no handle; screw-type plastic cover; Emil Greiner Co No. M2716; (p/o Psychrometer Equipment ML-313/AM).	1		*	*
3, 4	7A1322-313/C5	**CLAMP,** support: plastic; 1½″ lg x ¼″ h x ⅛″ thk; Sig C dwg SC-D-12701-A; (one mounting hole and hook portion of clamp ⅛″ x 1⅛″ mtg/c; mounting hole 0.1285″ diam; hook ⅛″ wide with 1/16″ radius at rounded portion; used to retain thermometers in psychrometer support; p/o Psychrometer Equipment ML-313/AM).	2		*	*
3	7A1322-313/P2	**COVER,** ventilator: aluminum No. 14 (0.064″) B&S gauge; 5″ diam with 3 keyholes 120° from each other; Sig C dwg SC-D-12705-A; (each keyhole located at 1 13/16″ radius from center; eye of keyhole 1″ diam, slot 7/32″ wide with rounded end 1/64″ radius; 30° angle from center of cover between center of eye to beginning of rounded portion of slot; p/o Psychrometer Equipment ML-313/AM).	1			*
2 ⑪	7A1322-313/G1	**GASKET,** synthetic rubber: 2⅝″ OD x 1⅝″ ID x 1/16″ thk; used as seal between	2	4	*	*

* Indicates stock available.

32. MAINTENANCE PARTS FOR PSYCHROMETER EQUIPMENT ML-313/AM (contd).

Ref figure	Signal Corps stock No.	Name of part and description	Quan per unit	Running spares	Station stock	Region stock
		ventilator and flange of psychrometer support; (p/o Psychrometer Equipment ML-313/AM).				
3, 8	7A1322-313/G2	**GUARD,** thermometer: aluminum; consists of wire screen sweated into holes in locknut; 3¼″ lg; Sig C dwg SC-D-12700-A; (locknut 9/16″ thk x 1 1/16″ OD x 3/8″ ID; head 5/16″ lg, medium diamond knurled with 1/64 x 45° chamfer; 5/8-24 thread for ¼″; thread relieved for 1/16″, diam at relieved portion ½″, inner diam at re-relieved portion tapered at 45° angle; four holes 3/16″ deep, 0.0670″ diam, 90° apart at 9/32″ radius parallel to bore of nut to accommodate wire screen; wire screen consists of 2 aluminum wires No. 14 (0.064″) B&S gauge bent in U-shape and tack welded at curved portion of U to each other at 90° angle, overall dimensions 2 7/8″ with ¼″ radius); p/o Psychrometer Equipment ML-313/AM.	4		*	*
3	2Z8304.46	**SHIELD:** support; aluminum No. 16 (0.050″) B&S gauge thk; round; open ends; friction mounting; 10″ lg x 1 5/8″ diam; split along 10″ length and separated for ¼″; Sig C dwg SC-D-12700-A; (shields thermometer tubes in psychrometer support; legend shield for Psychrometer Equipment ML-313/AM stamped centrally on shield in 1/8″ letters 1/64″ deep; p/o Psychrometer Equipment ML-313/AM).	2			*
2 ②	7A1322-313/S1	**SUPPORT:** aluminum; No. 16 B&S gauge; Sig C dwgs SC-D-12701-A, SC-D-12700-A; (p/o Psychrometer Equipment ML-313/AM).	2			*

* Indicates stock available.

32. MAINTENANCE PARTS FOR PSYCHROMETER EQUIPMENT ML-313/AM (contd).

Ref figure	Signal Corps stock No.	Name of part and description	Quan per unit	Running spares	Station stock	Region stock
2 ③	7A1322-313/T1	**THERMOMETER:** angle; mercury; —0.2° C to 50° C; special; Tagliabue Mfg Co; (p/o Psychrometer Equipment ML-313/AM).	2	3	*	*
2 ⑧	7A1322-313/T2	**THERMOMETER:** angle; mercury; —35° C to +15° C; special; Tagliabue Mfg Co; (p/o Psychrometer Equipment ML-313/AM).	2	3	*	*
2 ⑤	7A1322-313/V1	**VENTILATOR:** aluminum; overall dimen when assembled 17¾" x 6¼" x 10¾"; Sig C dwg SC-D-12703-A; (p/o Psychrometer Equipment ML-313/AM).	1			*
2 ⑨	7A1322-313/W1	**WICK:** cotton; white; United Braid and Lace Co No. B862; (Psychrometer Equipment ML-313/AM).	1	1	*	*

* Indicates stock available.

SECTION XII
PREPARATION OF TABLES IV AND V

33. PREPARATION OF TABLE IV.

(a) The temperature corrections for table IV are determined by the formula

$$\triangle t = \alpha \left(\frac{v_t}{100}\right)^2$$

where $\triangle t$ is the temperature correction in degrees centigrade, α is the fraction of full adiabatic heating applicable for the ventilator and thermometer arrangement of Psychrometer Equipment ML–313/AM, and v_t is the true air speed in miles per hour. To derive the formula, proceed as follows:

(1) From the First Law of Thermodynamics for an adiabatic process,

$$J\, c_p\, dT - \frac{dp}{\rho} = 0$$

and from Bernoulli's theorem,

$$v\, dv + \frac{dp}{\rho} = 0$$

Combining the above two formulas,

$$J\, c_p\, dT + v\, dv = 0$$

where J is the mechanical equivalent of heat (4.185×10^7 ergs per calorie),

c_p is the specific heat of air at constant pressure in mechanical units (0.2399 calories per gram per degree),

T is the temperature of the air in degrees absolute, which varies from the temperature of the free air to the temperature indicated at the thermometer bulbs,

p is the pressure in dynes per square centimeter, which varies from ambient pressure to the pressure at the thermometers.

ρ is the mean density of the air in grams per cubic centimeter,

v is the speed of the air in centimeters per second which varies from the true air speed of the airplane to zero at the thermometers.

(2) By integration, the third formula of subparagraph (1) above becomes

$$\int_{T_t}^{T_t + \triangle t} dT = \int_0^{v_t} \frac{v\, dv}{J\, c_p}$$

$$\triangle t = \frac{v_t^2}{2J\, c_p}$$

where T_t is the free air temperature in degrees absolute,

$\triangle t$ is the difference between the free air temperature and the temperature of the air at the thermometers in centigrade degrees,

v_t is the true air speed of the airplane in centimeters per second.

When v_t is expressed in miles per hour (100 mph $= 44.7 \times 10^2$ cm/sec),

$$\triangle t = \frac{(44.7 \times 10^2)^2}{2 J c_p} \left(\frac{v_t}{100}\right)^2$$

$$\triangle t = \alpha \left(\frac{v_t}{100}\right)^2$$

(3) For full adiabatic heating,

$$\alpha = \frac{(44.7 \times 10^2)^2}{2 J c_p} = 1$$

Depending upon the form of the thermometer and the nature of the air flow, α for any given thermometer arrangement has a value of 1.0 or less.

b. Flight tests throughout a wide range of air speeds have accurately determined α for Psychrometer Equipment ML–313/AM to be 0.87. These flight tests consist of level flight in an atmosphere of constant temperature with temperature observations being made throughout the range of air speeds of the airplane. The α value is the slope of the line determined by plotting the observed temperature values as a function of the square of the true air speeds. If the psychrometer is installed as described in paragraphs 8 and 10, the α value is not significantly affected by installation on different airplanes, and table IV gives accuracy in keeping with the accuracy of the psychrometer.

34. PREPARATION OF TABLE V.

a. The pressure increments of table V are determined by the formula

$$\triangle p = \alpha(\tfrac{1}{2}\rho v_i^2)$$

where $\triangle p$ is the pressure increment in dynes per square centimeter,

α is the fraction of full dynamic pressure increase at the thermometers,

ρ is the mean density of the air in grams per cubic centimeter,

v_i is the calibrated indicated air speed in centimeters per second.

The above formula is obtained by differentiation of the formula expressing Bernoulli's theorem.

b. Repeated tests in which $\triangle p$ was measured in the ventilator of Psychrometer Equipment ML–313/AM have shown that the value of α in the above formula is the same (0.87) as the fraction of full adiabatic heating which occurs at the thermometers and which is described in paragraph 33**b**. Values of $\frac{1}{2}\rho v_i^2$ in terms of indicated air speed in miles per hour were obtained for use in preparing table V from AAF Specification No. 27987-A, Amendment No.

2, August 20, 1943, Table, Pressure-Differential (For Airspeed Indicators), using the value of differential pressure in inches of water and converting to millibars by multiplying by the factor 2.49082.

SECTION XIII
REFERENCES

35. TECHNICAL PUBLICATIONS.

AAF TO No. 05–30–1, Handbook of Service and Operation Instructions, Altimeter C, D, and H Types.

AAF TO No. 05–20–8, Handbook of Instructions, Calibration of Airspeed Indicator Installations.

AAF TO No. 05–35–32, Operating of True Air Speed Computer, Type AM 5836–1.

AAF TO No. 05–35–17, Type G–1, True Air Speed Computer.

AAF Specification No. 27987–A, Amendment No. 2, Table, Pressure-Differential (For Airspeed Indicators).

36. FORMS.

Form SC No. 421, Psychrometer Equipment ML–313/AM Flight Data and Computation Sheet.

Form SC No. 400, Correction Sheet for Psychrometer Equipment ML–313/AM.

AAF Form No. 21E. Class 30B.

AAF Form No. 21M.

37. LIST OF ABBREVIATIONS.

AAF	Army Air Forces
C	centigrade
cgs	centigrade-gram-second
cm	centimeter
diam	diameter
fig.	figure
in.	inch
lb	pound
mb	millibar
mph	mile per hour
No.	number
par.	paragraph
ref	reference
sec	second
subpar.	subparagraph
TO	technical order
TM	technical manual
wt	weight

38. GLOSSARY.

The following glossary contains information in explanation of the technical meteorological terms used in this technical manual.

Abrasive. Any grinding material.

Adiabatic process. Any process in which compression or expansion of a gas takes place without the loss or gain of heat or energy.

Altimeter installation correction. The correction applied to the altimeter reading to compensate for the disturbed pressure field surrounding the pitot-static head.

Altimeter scale correction. The correction applied to the altimeter reading to compensate for the inherent error in the altimeter mechanism.

Ambient pressure. The pressure of the medium surrounding an object. It is the same as static pressure.

Calibrated air speed. The *indicated air speed* corrected for instrumental and installation errors of the air speed indicator installation.

Calorie. The heat required to raise the temperature of 1 gram of water by 1° C at 15° C.

1 gram calorie $=$ 4.18 joules $=$ 4.18×10^7 ergs.

Caustic soda. Another name for sodium hydroxide (NaOH). It is much used for cleaning and scouring.

CGS. A standard system of physical measurement in which the centimeter is the unit of length, the gram the unit of mass, and the second the unit of time.

Dew point. The temperature to which the air can be cooled at constant pressure without causing condensation. It is the temperature for which the saturation vapor pressure is identical with the pressure of the vapor in the air.

Dynamic pressure. The product of $\frac{1}{2}\rho v^2$ where ρ is the density of the air and v is the velocity of the air.

Effective pressure. The pressure which occurs at the point of temperature measurement in the ventilator of the psychrometer.

Erg. The unit of energy or work in the cgs system of units. It is the work done by a force of 1 dyne acting through a distance of 1 centimeter in the direction of the force. The erg is so small that the joule (10^7 erg) is used as a more practical unit.

Flare. A spreading outward or upward as of the sides of a bell or cone.

Fuselage. The body of an airplane to which are attached the wings and tail unit.

Humidity. The condition of the atmosphere in respect to water vapor. Air

may be described as humid when it has a high moisture content, but when the word humidity is used without a qualifying adjective the *relative humidity* is usually meant.

Increment. The amount which a varying quantity increases between two of its stages.

Indicated air speed. The speed of the airplane as read from the air speed indicator.

Installation error. The error introduced in the measurement of ambient pressure from high speed aircraft by the disturbing effect of the airplane on the surrounding air.

Instrumental error. The error introduced by inaccuracies in the instrument.

Interpolation. The act of computing intermediate values of a quantity between a series of given values.

Laminar flow. A particular type of streamline flow near solid boundaries where the flow is not *turbulent.*

Lucite. A trade name for a transparent, plastic material composed of polymethyl methacoylate; the same material as *Plexiglas.*

Manometer. An instrument used to measure the pressure of gases.

Millibar. The thousandth part of a bar which is the meteorological unit of atmospheric pressure in the cgs system. The millibar is equivalent to 1,000 dynes per square centimeter.

Parallax. An apparent change in the position of an object caused by a change in the position of the observer. In connection with the reading of meteorological instruments, an error of parallax may arise whenever the indicator of the instrument and the scale against which the indicator is to be read are at a distance from one another which is comparable with the length of the smallest readable scale division; for in such a case a movement of the observer's head may cause his line of vision to the indicator to intersect the scale at different points and so give rise to different readings. The error is eliminated by insuring that the line of vision to the indicator is at right angles to the scale when the reading is taken.

Pitot-static tube. The parallel or coaxial combination of pitot and static tubes. The difference between impact and static pressures is a function of the velocity of flow past the tube.

Pitot tube. A tube of small bore placed with its open end in a moving fluid (either liquid or gaseous) so that the pressure exerted in the tube may be measured and thus indicate the velocity of the fluid.

Psychrometer. An instrument used to measure atmospheric humidity. It

consists of two thermometers, the bulb of one of which is kept moistened. When the psychrometer is ventilated by air passing over the thermometer bulbs, the psychrometer gives two readings—a dry-bulb and a wet-bulb reading. By means of suitable formula, these readings may be readily converted to various forms of the atmospheric humidity.

Radiant heat. The energy transmitted through space which increases the molecular vibration within bodies with which it comes in contact. The bodies so affected experience a rise in temperature.

Radiation. The act of issuing and spreading in all directions from a center as the radiation of heat or light from a heated or shining body.

Relative humidity. The ratio, expressed as a percentage, of the actual amount of water vapor in a given volume to the amount which would be present if the space were saturated at the same temperature.

Shim. A piece of wood or metal placed beneath an object for the purpose of leveling or truing.

Slip stream. The stream of air driven astern by the propeller.

Specific heat. The relative amount of heat required to raise the temperature of a unit mass of a substance 1° compared with the amount of heat required to raise the same weight of water 1°.

Stay bolt. A threaded rod which is used to prevent bulging of the plates or parts through which it passes.

Stud bolt. A bolt threaded at both ends.

True pressure. The term applied in this manual to the pressure measured by the altimeter after all corrections have been applied. It is the same as ambient pressure.

Turbulence. The irregular motion which appears in fluids, whether liquids or gases, when they flow past solid substances or when neighboring streams flow past or over each other, provided the velocity of flow is greater than a certain limit.

Vapor pressure. The pressure exerted by the vapor of a liquid. In meteorology, vapor pressure refers exclusively to the pressure of water vapor.

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